SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1918.

GENERAL PHYSICS.

441. *A Simple Measuring Machine.* (Engineer, 125. p. 302, April 5, 1918.)—This machine, made by Armstrong, Whitworth and Co., Ltd., is of a form now well known. But it is adaptable to a variety of measurements for plate, plug, screw, and other work. The device used for indicating contact is the original Whitworth method of "feeling" contact between the gauge on one side and the measuring spindle end on the other, by a light cylindrical feeler. The ends of headstock and tailstock spindles are formed to receive and hold hardened steel points, the form of which is varied according to the work being gauged. For taking the major diameter of screw gauges two plate-like contact pieces are fixed to the spindles. For effective diameter one needle is inserted between the plate and fitting into a groove of the screw. For core diameter one plate is removed and is replaced by a contact piece ending in a circular non-rotating disc which can reach to the root of the groove. P. E. S.

442. *Self-recording Evaporimeter.* **A. McAdie.** (Phys. Rev. 11. pp. 147–148, Feb., 1918. Abstract of paper read before the Am. Phys. Soc., Oct., 1917.)—At Blue Hill Observatory evaporation is continuously recorded by means of a weighing device which is found much more satisfactory than the usual method of taking eye readings from an evaporation pan. Deposition of small amounts of dew when the water is at a lower temperature than the surrounding damp air is well shown by the instrument as negative evaporation, *i.e.* an increase of weight. The max. rate of evaporation recorded is 1 mm. loss per hour on the afternoon of July 30, 1917. Other conditions at the time were—temperature 96° F., humidity 37–48 %, and wind 14 m./sec from W. J. S. D

443. *Experimental Study of Vibrations and Application to Alternating Currents.* **A. Poucholle.** (Rev. Gén. d. Él. 3. pp. 387–395, March 16, 1918.)—The author here describes an ingenious apparatus due to Gueugnon. It is a modification of Atwood's machine that winds on the axle of the wheel a tape on which the style of a pendulum moves to and fro horizontally and thus plots experimentally a graph of the vibratory motion. A further arrangement consists of two pendulums vibrating simultaneously in like or opposite phases, etc. The motion resulting from the composition of the two pendulum vibrations is then used to plot a graph on the tape.

The paper has many diagrams of the apparatus and the curves obtained by it. E. H. B.

444. *Production and Measurement of High Vacua.* **J. E. Shrader** and **R. G. Sherwood.** (Phys. Rev. 11. pp. 134–135, Feb., 1918. Abstract of paper read before the Am. Phys. Soc., Oct., 1917.)—During work on the diffusion pump the authors have designed a pump with certain improvements. Its construction is of the upright form and so designed that the condensed mercury returns to the boiler without passing through the high-vacuum side. This obviates the objectionable feature of Langmuir's early pump in which the condensed mercury came into contact with the hot tube from the boiler, thus producing a mercury-vapour blast against the intake side of the pump. The upright form is easier for the glass blower to manipulate, is more convenient for attaching the water-jacket, and makes unnecessary the insulation of the stem connecting the boiler to the other part of the pump. The pump is quite effective, pressures lower than 1×10^{-8} mm. of Hg having been attained.

The Knudsen type of absolute manometer has been chosen as best suited for the measurement of low pressures. A gauge possessing important improvements over those previously described in the literature of the subject has been constructed. These improvements consist in the method of supporting the Pt heating strip, the kind of suspension, and the manner of suspending and controlling the movable vane. Without heat-treatment of a glass system, pressures as measured by this gauge lower than 1×10^{-6} mm. of Hg cannot be attained. With continued heat-treatment at 500° C. of the entire hard glass system, pressures lower than 1×10^{-8} mm. of Hg have been obtained, and many glass vessels have been exhausted to pressures of the order of 5×10^{-8} mm. of Hg. Tests of the pump in connection with the gauge showed that with low backing pressure, 3×10^{-4} mm. of Hg, the pump begins to operate at 65 watts in the heater, and the speed of exhaustion increases with the wattage up to 300 watts. From 300 to 350 watts the increase in speed is much less, and from 350 to 600 watts the speed is practically constant. It also appeared that the critical backing pressure is a linear function of the vapour pressure of mercury. A. W.

445. *Elasticity Ratios of Palladium charged with Hydrogen.* **K. R. Koch.** (Ann. d. Physik, 54. 1. pp. 1–37, Feb. 8, 1918.)—A number of palladium wires were investigated, their electrical resistances and moduli of elasticity and torsion being measured first in the absence of hydrogen and then with gradually increasing hydrogen charge. The results for the first wire showed that when the Pd was exposed to hydrogen for 448 hours its resistance increased in the ratio 1·65 : 1, while its modulus of elasticity decreased about 11 % and its modulus of torsion about 7 %. Similar results were obtained with the other wires used, one of which showed an increase of resistance of nearly 100 %, corresponding to an absorption of hydrogen of amount 1112 times that of the wire. At the same time the modulus of elasticity was reduced by about 9 % and the modulus of torsion about 12 %, though in the case of the modulus of torsion an increase was observed at first, up to an absorption of 230 times the volume of the wire, beyond which the value of the modulus fell rather quickly. [See Abs. 1316 (1915).] A. W.

446. *Effect of Great Hydrostatic Pressure on the Physical Properties of Metals.* **Z. Jeffries.** (Inst. of Metals, J. 18. pp. 243–247; Comm., 248–252, 1917. Engineering, 104. p. 357, Oct. 5, 1917.)—Gives the results of experiments which indicate that the result of hydrostatic pressure of 12,400 kg./cm.^{2} on cylinders of Al and Al-Cu alloy does not cause any increase in hardness or tensile strength. These results contradict Hanriot's results, who obtained an increase in hardness of 30 % by the application of hydrostatic pressure of about 10,000 kg./cm., using vaseline to transmit the pressure. C. O. B.

447. *Researches made possible by the Autographic Load Extension Optical Indicator.* **W. E. Dalby.** (Inst. of Metals, J. 18. pp. 5–43, 1917. Lecture. Engineer, 123. pp. 422–423, May 11; 453–454, May 18, and pp. 468–470, May 25, 1917.)—Describes in detail the instrument used; in this a steel bar measures by its optically magnified extension the load on the specimen. The extension of the steel bar is measured by the movement of a spot of light focused on the camera screen, and the inertia of the heavy steelyard and jockey weight is eliminated. Light mechanical linkage is used to convert the extension of the specimen into the small angular movement of a light mirror within the instrument.

The instrument has certain special advantages, for instance, the absence of pencil friction, and brings out on the diagram irregularities in the line due to the metal itself.

From the collection of diagrams illustrating the lecture, the curves are seen to distinguish the metals into individuals, whilst from the diagrams as a whole it is seen that they fall into two groups. The first group includes copper, various copper alloys, zinc, tin, etc., all of which show a smooth curve continuous from origin to break, with the exception of brass, where small irregularities are seen on the curve as the metal draws out. These irregularities are so typical of brass that the metal can be identified by means of them.

The second group includes iron and the carbon steels. The curves are no longer continuous from origin to break, but show a discontinuity between the elastic part, which appears almost vertical in the diagrams, and the plastic part.

The measurement of the ductility of metals is discussed. An instrument specially suitable for short specimens is illustrated and described, and the influence of gauge length on the extension obtained is discussed.

The influence of the ends on the extension, tenacity, and contraction of area, is described and illustrated, and the question of the validity of the law of similarity in connection with short specimens is discussed in the light of the results obtained.

The application of the method to quick-acting testing-machines is described and illustrated, and the effect of rapid breaking is shown. C. O. B.

448. *Long-range Guns.* **A. Mallock.** (Nature, 101. pp. 84–85, April 4, and p. 125, April 18, 1918.)—The appearance of a gun with a range of 70–80 miles has brought up the question as to how such long ranges are attained. The author answers that if the shot is to travel far, it must get outside the atmosphere, or, rather, to a height where the density of the air is very small, and that it must be started with such a velocity that in spite of the air-resistance in the first part of its course, its remaining speed, after having reached the upper air, shall be sufficient for its further progress. If the temperature of the air at all heights were constant, the air itself would extend to

an infinite height, the pressure and density being connected to well-known laws. If, on the other hand, the temperature decreases adiabatically with the height (which is the case up to about 40,000 ft.), there is a finite limit of about 17 miles above which no oxygen or nitrogen could exist. Above this height a projectile would experience no resistance, but even a few miles lower the resistance would be small compared with its weight. The requisite initial velocity for a 9-in. shot (such as is said to have been used in the German gun) must be of the order of 5000 ft. per sec. To attain this velocity a long bore appears to be more suitable, from the author's experiment, than an extra-strong explosive. For a 70 or 80 miles' range, the shot, after attaining a height where the air-resistance is very small, must have a remaining velocity of between 2000 and 3000 ft. per sec. The trajectory of the projectile is part of a very long ellipse.

In the second note the author states that the heading of the velocity column should have been "Horizontal component of initial velocity," not "Initial velocity." He then proceeds to find the elements of the elliptic orbit of the projectile, namely, at the vertex of the trajectory the weight of the projectile is just balanced by centrifugal force, and since the radius of curvature of an ellipse at the end of the major axis is b^2/a, $b^2/a = v^2/g'$, where v is the velocity in apogee and g' the earth's attraction at that distance; also since $b^2 = a^2(1-e^2)$, it follows that $e = 1 - v^2/R'g'$, where R′ is the apogee distance of the projectile from the centre of the earth, and $b = R'\sqrt{[(1-e)/(1+e)]}$. A short table of v and b is appended. If $R' = R + H$, R being the earth's radius and H the greatest height of the trajectory above the earth's surface, and if, also, θ is the angular distance between the major axis of the ellipse and point where the orbit cuts the surface of the earth, the range is $2R \sin\theta$, θ being determined by the equation $\cos\theta = (R' - He)/R$.

H. H. Ho.

449. *Action of Rotating Distant Masses in Einstein's Gravitational Theory.* **H. Thirring.** (Phys. Zeits. 19. pp. 33-39, Feb. 1, 1918.)—The paper commences with a citation from Einstein's fundamental work of 1914, showing that an extension of the relativity theory is not to be looked for on physical grounds. The later publication by Einstein in 1915 brings up the question of whether the new hypothesis is free from the objections to the Newtonian theory, since the rotations of distant masses produce, according to their equations, a gravitational field which is equivalent to a centrifugal field. The boundary conditions for $g_{\mu\nu}$ are found to have a rôle in spacial infinity. The author therefore considers a special concrete example of a field influenced by rotating masses at a distance, and employs as especially suitable Einstein's approximate integration method for the field equations. The field chosen was the interior of a uniformly rotating, infinitely thin, hollow sphere, which is of constant mass density. In the first section of the paper the approximate calculation of $g_{\mu\nu}$ for the interior of the spherical shell is obtained; in the second section the motion of a material point in the field is discussed. It is shown in the above example that effects occur which are analogous to centrifugal forces.

H. H. Ho.

450. *Gravity.* **Guillet.** (Comptes Rendus, 165. pp. 1050-1052, Dec. 24, 1917.)—For measurement of g, the author advocates Newton-tube methods, involving direct observation of the time of fall, and promises experimental particulars.

A. D.

451. *Oscillations in an Irregularly Variable Field of Force.* **A. Schmidt.** (Preuss. Akad. Wiss. Berlin, Ber. 46. pp. 609–622, 1917.)—The paper consists of an analysis of the theory of oscillations in an irregularly variable field, in connection with observations of terrestrial magnetism. C. P. B.

452. *On a Solution System of the General Covariant Gravitational Equations.* **E. Schrödinger.** (Phys. Zeits. 19. pp. 20–22, Jan. 15, 1918.)—Recently Einstein [Abs. 455 (1917)] has published a system of energy components $T^{\mu\nu}$ and of gravity potentials $g_{\mu\nu}$, which exactly integrate the general covariant field equations, and from which he assumes that they will afford an approximation to the actual structure of matter and of space. The original form of the field equations, however, has been somewhat altered. Einstein's conception of the closed space appears to the present author to possess quite extraordinary significance for the general theory of relativity. He points out that the complete solution system for the field equations in their original form without Einstein's terms was already in existence, and now demonstrates that the difference is very slight, namely, the potentials remain unchanged, and only the energy tensors have a different form. The author discusses the older process, and shows that the calculation offers no difficulties, but runs exactly like that of Einstein. H. H. Ho.

453. *Gravitation Theories.* **L. Bloch.** (Comptes Rendus, 166. pp. 111–113, Jan. 21, 1918.)—A mechanical theory will satisfy Hamilton's principle (H) if all the equations of motion are of the form $A_q(T)=0$, where $A_q(T)$ is Langrange's operator $dT/dq - d/dt(\partial T/\partial \dot{q})$. If T does not explicitly contain the coordinates or their derivatives, but only the mutual distances and their derivatives, the theory may be said to satisfy the *relativity principle of Hamilton* (H_R), provided the equations are of the form $A_r(T)=0$. The author then points out that:—(1) Tisserand's gravitation theory, which consists in substituting Weber's electrodynamic law for the law of Newton, satisfies (H), and an equation satisfying (H_R) is deducible from it. (2) Reissner's theory [Abs. 1203 (1914), 1179 (1915)] satisfies (H_R) by its definition, being a particular case of a slightly more general theory in which the law of elementary action is that of Weber. It is therefore the extension of Tisserand's theory which is immediately suggested by the relativity theory. (3) Einstein's theory, in its first approximation, accepts the classical electrodynamic relations modified by the introduction of the numerical factor 1/2 in the static term. In its second approximation it is expressible in terms of the law of Gauss modified by the introduction, in the static term, of the factor $1+\alpha/r$, where α is a number independent of the attracted mass, and which for the case of the Sun has the value 3×10^5 cm. It accounts for the anomaly in the motion of Mercury's perihelion. (4) Identically the value for this celebrated anomaly can be obtained from Weber's law by modifying its static terms by the same factors 1/2 and $1+\alpha/r$. When the Gauss-Einstein formula is employed, the independent variable is the time proper to the moving body, while if Weber's formula be employed, it is ordinary time. This double correction implies the relativity of the inert mass exactly as in the theories of Reissner and Einstein, and suffices practically to bring Tisserand's theory into agreement with the relativity principle of Hamilton. G. W. DE T

454. *Use of Mercury Droplets in Millikan's Experiment.* **J. B. Derieux.** (Phys. Rev. 11. pp. 203–226, March, 1918.)—Consistent results are obtainable from the use of mercury droplets if the necessary precautions are taken. The greater variation in the results at reduced and varying pressures is considered to be due, partly at least, to the higher rate of evaporation present during this part of the work.

The values found for the correction term constant, A, for Stokes' law are at atmospheric pressure 0·695, reduced pressures 0·705, and varying pressures 0·730. In taking the mean, the author gives the above values the weights 3, 2, 1 respectively, thus finding for A the final value 0·704.

The value of $e^{2/3}$ obtained from the mean of the results at atmospheric and reduced pressures is $61{\cdot}12 \times 10^{-8}$, which is practically the same as that obtained from the use of oil, namely $61{\cdot}13 \times 10^{-8}$. E. H. B.

455. *Hamilton's Principle and the Canonical Equations of Dynamics.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 46. pp. 606–608, 1917.)—Both Hamilton and Jacobi have shown that where H is a function of the coordinates q_i, the impulses p_i, and the time t, the canonical equations $\dot{p}_i = -\partial H/\partial q_i$, $\dot{q}_i = \partial H/\partial p_i$...(1) are integrable if a function J of q_i and t can be found satisfying the equation $\partial J/\partial t = -\overline{H}$...(2), where $\overline{H}$ is derived from H by substituting $\partial J/\partial q_i$ for p_i; and that, if J be a complete integral of this equation with integration constant a_i, then the equations $\partial J/\partial q_i = p_i$, $\partial J/\partial a_i = \beta_i$...(3) give the general integral of the canonical equations (1).

Every textbook of advanced dynamics contains a proof that (1) will necessarily be true if (2) and (3) be true, but the author is unaware of the previous existence of any general proof of the converse theorem, which he here demonstrates, that if the canonical equations (1) be true, then the Hamiltonian equations (2) and (3) are necessarily true. G. W. DE T.

456. *On Two-dimensional Fluid Motion, with Free Stream-lines, Past an Obstacle of Curved Outline.* **J. G. Leathem.** (Roy. Irish Acad., Proc. 34. pp. 11–39, March, 1918.)—The author commences by giving in chronological order a list of papers to which he refers on the subject of two-dimensional flow of infinite liquid, with free stream-lines, past a fixed obstacle of curvilinear outline. [For the author's previous paper on "Two-dimensional fields of flow, with logarithmic singularities and free boundaries," see Abs. 644 (1916).] In these researches there have been three distinct objectives: (i) A mathematical formulation, in terms of somewhat general functions, for any motion bounded partly by fixed and partly by free boundaries. (ii) The exact or approximate adaptation of such a general formula to the case of an obstacle of arbitrarily assigned outline. (iii) The choice of such forms of obstacle as shall correspond to liquid motions that can be precisely specified.

The exact adaptation of a general formulation to the case of an assigned obstacle seems bound to depend upon difficult functional equations, upon whose solution further progress must wait. The primary objective of a comprehensive formulation remains of fundamental importance, since such may well be the only possible point of departure for further progress in general theory, and the present paper offers a general formulation in terms of conformal curve-factors—functions whose properties the author has discussed in previous papers. The method leads to expressions in terms of a definite integral involving a single arbitrary function of a real variable, and it is believed that in this form the properties of the relation between the fundamental variables are exhibited as simply as possible. From this formulation as starting-point it has proved feasible to make a certain advance in knowledge, for there are obtained formulæ which specify the most forward points at which free stream-lines can break away from an obstacle with smoothly curved sides. Attention is called to a probable connection between the positions of these points and the resistance which the obstacle offers to the stream when there are no free stream-lines but the "wake" is in rotational motion; and a principle is deduced which may have important bearing on the problem of designing cylinders of small resistance—as, for example, struts for aeroplanes. The various sections of the paper respectively deal with:—Notation and formulation; General formulæ; Demonstration of generality; Determination of the points of departure of free stream-lines from a curved obstacle; Influence of the shape of the obstacle upon the divergence of the free stream-lines, and the resistance to relative flow. The subject is treated mathematically throughout

H. H. Ho

457. *Physical Significance of the Relativity Postulate; Einstein's New and Original Theories of Relativity.* **E. Kretschmann.** (Ann. d. Physik, 53. 16. pp. 575–614, Feb. 1, 1918.)—In his Introduction, the author first considers the various forms whereby different authors have expressed the postulate of the Lorentz-Einstein Relativity Theory, and especially deals with the recent general Relativity Postulate of Einstein [see Abs. 148, 853 (1916)], namely: that a system of physical laws satisfies a Relativity Postulate if the equations by which it is determined are covariant to the transformation group of the space and time coordinates. In Part I the physical significance of the Relativity Postulate is developed. In II the principal measurement of the components $g_{\mu\nu}$ of Einstein's gravitational potential is dealt with. In III the limitations to the covariance of the Einstein equations are considered in 5 sub-divisions, viz. (1) The use of axial directions of the curvature tensor as coordinate directions. (2) The introduction of absolute invariants as space and time coordinates. (3) More accurate determination of the reference system under the $g_{\mu\nu}$ imposed conditions. In Part IV the geometrical determination of the complete Relativity Postulate of Einstein's latest theory is considered, and a comparison made with his original hypothesis. The concluding section deals with the defects of the general Relativity Postulate.

H. H. Ho.

458. *Molecular Frequency and Molecular Number.* **H. S. Allen.** (Phil. Mag. 35. pp. 338–349, April, 1918.)—After referring to Moseley's work and the importance of the "atomic number" the author introduces a new term when referring to compound substances, namely: the "molecular number," to signify the sum of the positive charges carried by the atomic nuclei contained in the molecule. Thus, when a molecule contains a atoms of an element A, b atoms of B, c atoms of C, so that its chemical formula is $A_aB_bC_c$ the "molecular number" is $N = aN_a + bN_b + cN_c$, where N_a, N_b, N_c are the atomic numbers of the component elements. It is interesting to note that the "molecular number" is usually, though not invariably, even. This arises from the fact that when the valency is odd the atomic number is usually odd also. The author's conclusions with regard to the main question of the relation between molecular frequency ν and molecular number N are as follows:—It has been proved that the product $N\nu$ frequently shows related values for analogous compounds. There is a considerable amount of evidence for the validity of a formula of the type $N\nu = n\nu_A$ (where n is an integer and ν_A a fundamental frequency having a value very near to 21×10^{12} sec.$^{-1}$) in the case of most inorganic solid compounds and of a number of organic compounds. To what extent the formula is to be considered approximate can be decided only when further data as to the specific heat of solids at low temperatures are available. The physical significance of such a formula has been discussed in an earlier paper [Abs. 226, 227 (1918)]. Perhaps the simplest interpretation that can be suggested for the "frequency number" *n* is that it is related to the number of valency electrons concerned in imparting to the solid its crystalline structure. Further investigation on these lines may serve to throw more light on the nature of the forces connecting the molecules, and the problem of molecular association, in crystalline solids.

A. B. W.

459. *On the Theory of the Brownian Movement and the Experiments of Brillouin.* **H. C. Burger.** (K. Akad. Amsterdam, Proc. 20. 5. pp. 642–658, 1918.)—The purpose of the inquiry was twofold, namely: (1) To give a rigorous proof of some well-known formulæ of the Brownian movement, with and without external force. (2) To trace the boundary-condition at a fixed wall and to interpret some experimental results concerning this. The paper is rigidly mathematical throughout, and in consequence must be consulted in its entirety.

H. H. Ho.

460. *Rain, Wind, and Cyclones.* **R. M. Deeley.** (Phil. Mag. 35. pp. 221–236, March, 1918.)—The author points out that many of the old preconceived notions as to the structure of cyclones have had to be revised in the light of recent knowledge. However, it cannot be doubted that rain is an indication of rising air, since the condensation cannot be brought about by any other means than the cooling due to adiabatic expansion produced by ascent. This inference is borne in mind in looking into the mechanism of certain depressions, and deductions are drawn as to the upper-air movements. In the latter part of the paper the theory of the causation of cyclones is considered.

In the stratosphere the air over a depression is relatively warm up to the greatest height which has been explored with registering balloons, and the data at present available show that the air at great heights over the poles is similarly relatively warm compared with that over the equatorial regions. The present author has previously suggested that this heating of the air over the poles is due to the electrons shot out by the sun, which being caught by the earth's magnetic field, are directed towards the poles, the air in the neighbourhood of which they heat and probably ionise. The suggestion is that this heating causes the air to rise with an outflow near the limit of the atmosphere, the supply of air being maintained by the incurvature of the air paths near the surface. Thus the polar depression is accounted for. If we may assume small pencils of cosmic matter which strike the upper layers of the atmosphere in a localised patch, the causation of a travelling depression may be similar to that described above for the polar depression. In this case the travel of the depression would be guided by the motion of the air in the top layers where the heating took effect. This heating is regarded as being produced rapidly and as dying away slowly. It is thought that this theory will account for the observed temperature distribution in a cyclone. It is in contradiction to that advanced by W. H. Dines, who concludes that a cyclone is produced by the withdrawal laterally of the air at a height of from 8 to 10 km.

J. S. Di.

461. *Revolving Fluid in the Atmosphere.* **J. Aitken.** (Roy. Soc., Proc. 94. pp. 250–259, April 2, 1918.)—N. Shaw has recently put forward the suggestion that the case of true revolving fluid in the atmosphere is not to be found in the typical cyclonic depression of temperate latitudes, though it may exist in the small secondaries which develop within these systems [see Abs. 8 (1918)]. The author of the present paper challenges this conclusion, and considers that there is no essential difference between the tropical revolving storm of the West Indian hurricane type and the North Atlantic depression; both being cases of revolving fluid. In the one case the pressure gradient is steep and the area covered small, while in the other the energy is distributed over a larger area and the winds are of more moderate force. It is considered that the analogy between the cyclone and the vortex ring may easily be pushed too far, the vortex ring being an essentially closed system while the cyclone is constantly drawing in fresh air in the lower layers. An interesting suggestion is made that the initial cause of the development of a secondary may be due to the down draught caused by the mechanical action of falling rain. A similar effect may be produced if a stream of sand is dropped into a revolving body of water in a circular pan, the flow of sand being guided to fall on to one portion of the moving water, as this travels round the pan. An eddy or "secondary" can thus be set up. J. S. Di.

462. *Researches in Far Eastern Seasonal Correlations.* IV. **T. Okada.** (Monthly Weather Rev. 45. pp. 535–538, Nov., 1917.)—In Northern Japan the August temperature is the dominant factor for the rice crop of the year, a high temperature being favourable to the crop. It is thus of great importance to arrive at some means of forecasting the temperature in August some months in advance. The author has previously traced a connection between this temperature and certain meteorological elements in other parts of the world earlier in the year [see Abs. 339 (1918)]. In the present paper correlation coefficients are worked out and regression equations formed. In calculating the correlation coefficients, differences of the various elements from one year to the next are used instead of departures from the normal. The regression equation connecting August temperature in Northern Japan with the Azores–Iceland pressure difference in the preceding April, with the pressure difference between Zikawei and Miyazaki in March, and with the pressure at Sydney, N.S.W., in January gives changes of temperature from one year to the next which are of the right sign in all except three of the 24 years 1884–1907. Omitting the Sydney pressure term there were five errors in sign in a 29-year period. The largest correlation coefficient obtained is +0·61 between Japan temperature and Azores–Iceland pressure-difference. J. S. Di.

463. *Nebraska Hailstorm of August* 8, 1917. **G. A. Loveland.** (Monthly Weather Rev. 45. pp. 540–542, Nov., 1917.)—The hailstorm was of exceptional violence, and did widespread damage over a track of from 4 to 12 miles in width and 92 miles long running in a NW. to SE. direction. The time taken in travelling this distance was about 3 hours and 10 mins. A report of the passage of the storm gave the following changes. There was at first a SSW. wind and a little hail. Then a lull, after which the wind turned suddenly to the north and the hail came with a rush. The largest hail fell immediately after the change of wind, followed by smaller hail which fell in enormous quantities for 10 to 15 mins. Rain continued falling for some time afterwards. The total precipitation exceeded 1 in. (water) over most of the storm area. The storm seems to have been associated with the passage eastwards of a trough of low pressure, and probably owed its origin to the difference in temperature of the wind currents on the two sides of the trough. J. S. Di.

464. *Cloud Formations as Observed from Aeroplanes.* **C. K. M. Douglas.** (Nature, 101. pp. 85–88, April 4, 1918.)—The aeroplane forms a valuable means of investigating the properties of clouds, as not only can the height and thickness of a cloud be quickly determined, but observations of temperature in the surrounding air and the cloud itself can also be made. The "bumps" felt on the aeroplane afford some indication as to the degree of

turbulence associated with the cloud formation. The author considers that cloud sheets of the St. and St.-Cu. forms are the result of uniform turbulence associated with the "eddy conductivity" of G. I. Taylor. If the surface temperature remains unchanged this turbulence gradually establishes an adiabatic temperature gradient or lapse rate with condensation in the upper layers and a rise of temperature or inversion above the limit to which the turbulence extends. This type of cloud sheet is produced by the movement of a body of air over a wide stretch of sea of uniform temperature. The thickness of the sheet is usually less than 1500 ft. A photograph reproduced in the paper shows the top of such a cloud sheet in which the horizontal rolls indicating the turbulence are clearly seen. In extreme cases the rise of temperature above the sheet may amount to 15° F. in 1000 ft.

Clouds of the Cu. type are formed by turbulence on a much larger scale than that which leads to the horizontal cloud sheets. Winds crossing the irregular surface of the land or local differences of temperature give rise to this type of turbulence. The Cu. so formed may almost cover the sky, but the top of the cloud sheet shows much greater differences of level than the St. type. In one case illustrated the variation in level amounted to 1000 ft. If, associated with these conditions, there is a lapse rate above the cloud level exceeding the adiabatic for saturated air, the circumstances are favourable for the development of towering cumulus of the shower and thunderstorm types. The tops of thunderstorms are usually above 15,000 ft., and of heavy shower clouds above 10,000 ft. The upper cloud sheets which give rise to large areas of continuous rain are entirely independent of disturbances originating at the surface, and are due to upward air movements on a large scale. J. S. Di.

465. *Temperature Distribution in a Pond.* **T. Terada.** (Math. Phys. Soc., Tokyo, Proc. 9. pp. 240–243, Feb., 1918.)—The temperature distribution in a pond measuring about 60 by 80 metres was determined at different times of the year. Observations made in the winter months Nov. to March show a fairly uniform temperature throughout the depth (1–2 m.) with a rise of temperature downward in the soft mud at the bottom. Those made in April, May, and June indicate a temperature decrease of 2–3° C. per metre of depth in the water with a temperature gradient in the mud of the same sign which sometimes reaches a considerably greater value. No attempt was made to ascertain the diurnal variation at different depths, which must be considerable. The observations were all made in the afternoon. J. S. Di.

466. *Ultra-violet Transparency of the Lower Atmosphere and its Relative Poverty in Ozone.* **R. J. Strutt.** (Roy. Soc., Proc. 94. pp. 260–268, April 2, 1918.)—There is strong reason to think that the limitation of the solar spectrum at sea-level to wave-lengths exceeding λ2948 is due to absorption by atmospheric ozone. To test whether similar absorption by ozone occurs in passing through the layer of air nearest to the ground only, arrangements were made to photograph the spectrum of a quartz mercury-vapour lamp at distances ranging up to 4 miles. A cadmium spark was also used for distances up to 1200 yards. The latter source of light shows strong lines right through and even much beyond the region of strongest ozone absorption, and is therefore superior to the mercury-vapour lamp, but practical difficulties stood in the way of its employment at greater distances than 1200 yards. The experiments showed that the lower air is far more transparent to ultra-violet rays than the upper air if equal masses are considered. An approximate calculation shows that such absorption as does occur in the ozone region in the lower air might well be accounted for by the small dust particles in the atmosphere, and thus the present experiments afford no definite proof that ozone is existent in the air near the ground; but if such does exist it is demonstrated that the amount does not exceed a thickness of 0·27 mm. at normal pressure and temperature in 4 miles of air. It is quite clear that the air near the ground contains very much less ozone than the upper layers. J. S. Di.

467. *Significance of Glass-making to the Petrologist.* **N. L. Bowen.** (Washington Acad. Sci., J. 8. pp. 88–98, Feb. 19, 1918.)—Watching optical glass-making in the works of Bausch and Lomb, the author did not observe any immiscibility of the various silicates, though good stirring was required to accelerate their diffusion, whilst the "salt-water"—a liquid layer forming on the top of the glass when the alkaline carbonates contain considerable amounts of chlorides and sulphates—is really immiscible with the glass. There is thus no differentiation of silicate layers in the magma of igneous rocks (Gouy-Chaperon phenomenon). The small grains of silica which dissolve last, rise in the liquid glass, however, each surrounded by a layer of glass of low refractive index, which follows the grain in a long, fine tail pointing downward; the upper layers hence become richer in silica than the lower ones, but as time goes on diffusion tends to lessen this gradient. Further, when the mass begins to solidify two stages must be distinguished: when there is much liquid and little solid, and when the solid predominates; the effect of this in magmas is a sinking of crystals at the early stage and squeezing out of residual liquid from the crystals at a later stage. There will also be solution of the pot material (adjacent rock) by the glass and volatilisation of certain ingredients from the surface. Otherwise the author finds no reason for immiscibility and differentiation in magmas. H. B.

468. *Oscillations of the Deep-sea Surface caused by a Local Disturbance.* **K. Terazawa.** (Tôhoku Univ., Sci. Reports, 6. pp. 169–181, Nov., 1917.)—The much-discussed problem of Cauchy-Poisson connected with deep-sea water-waves has been solved by various writers for the case of an area removed from the initially disturbed region. In a former paper [Abs. 1608 (1915)] the author commenced a discussion of the oscillations at the centre of the area initially disturbed, for cases where the initial disturbance is spread over a certain extent of the free surface. In the present paper the author completes the examination of the problem of the central oscillations for some cases suggested in the former communication. The problem presents itself in two forms which vary in accordance with the initial conditions: (1) when an initial displacement of the free surface is given, without initial velocity; (2) when an initial impulse is applied on the surface, without initial surface displacement. Since the solutions in the present paper are entirely expressed in terms of a certain function $\nu(x)$ and its derivatives, which do not appear to have yet been fully worked out, the general properties of this function are first discussed prior to the main problem. $\nu(x)=e^{-x^2}\int_0^x e^{t^2}dt$. The paper is illustrated by 5 diagrams. The solution to problem (1) shows that the up-and-down motion of the free surface at the origin attains its max. amplitude only twice. The second maximum is far smaller than the first, which itself is smaller than the initial given elevation. In problem (2) the depression at the origin represents again a special type of aperiodic oscillation. It possesses 3 max. amplitudes in rather an early stage of its course, the first being the greatest and the last the least. After passing the third maximum the surface approaches asymptotically to its natural state. H. H. Ho.

469. *The Annual Period of the Microseismic Movement.* **O. Meissner.** (Phys. Zeits. 19. pp. 1–2, Jan. 1, 1918.)—The author has already [Abs. 467 (1917)] given the harmonic constants for the annual cycle of the short-period microseismic movement at various stations in North and Central Europe. He now records data for the Russian stations at Pulkowa, Taschkent, and Irkutsk, alongside which is given comparison figures of the sea movement off the Norwegian coast. The table shows the amplitude and phase of the annual component for the above stations compared with like data for Graz, Goettingen, Potsdam, Hamburg, and Upsala. The relationship between the microseismic movement and meteorological conditions (which vary widely from year to year), is briefly considered. The causal connection between sea motion and microseismic movement is discussed at some length; the max. value is seen to be at Hamburg and the direct influence of sea action is not to be denied. The latter effect on the Norwegian coast undoubtedly extends into the interior of Siberia.

H. H. Ho.

470. *Astronomical Consequences of the Electrical Theory of Matter.* **O. J. Lodge.** (Phil. Mag. 35. pp. 141–156, Feb., 1918.)—In continuation of the inquiry dealt with in former papers [Abs. 1343 (1917) and 135 (1918)], the author points out that, according to Eddington's modified equation, some perturbation seems inevitable of the amount reckoned in his first paper, if the extra inertia be unaffected by gravity, or of double this amount if it be fully subject to the Newton law of attraction. The outstanding facts are therefore—that a solar drift of a reasonable order of magnitude gives, according to the electrical theory, a correct value for Mercurial apsidal progress, and moreover a Martian apsidal progress also of correct magnitude; but, on the other hand, the changes in eccentricity are not correctly accounted for, and the calculated perturbations for the Earth and Venus exceed any probable value for these planets. These results seem to suggest that the theory must be, not inapplicable, but imperfect. The author considers various directions in which an improvement of the theory might be looked for, and is driven, by a process of exclusion, to seek it in the assumption that the gravitation constant may be a function of velocity, although, so far as he is aware, no reason for suspecting such variability has hitherto appeared, and that its changes act in a compensating manner. Should this prove to be the solution it would add considerably to the evidence in favour of an uncompromising Principle of Relativity. The author suggests that, in view of the importance of the question, it would be worth while to expend some labour in calculating what the perturbations would be, without assuming the variability of the gravitation constant with speed, for the four inner planets, given some favourable value of the solar drift. He then proceeds to work out some examples on the basis of Eddington's modified equation, in order to see how the theory can be made to work, and in the course of so doing he deduces the curious and interesting result that there would remain a residual perturbation due to fluctuating mass even in a solar system which was stationary in the ether. In support of the possibility of a dependence of gravitational attraction on speed, the author shows that, if the attraction were of an electrical order, such dependence on speed would be reasonable, and the amount of the dependence would be appropriate. G. W. DE T.

471. *Is a Moving Star retarded by the Reaction of its Own Radiation?* **L. Page.** (Nat. Acad. Sci., Proc. 4. pp. 47–49, Feb., 1918.)—A question of some interest to the astronomer is whether or not a body in motion, such as a star, is retarded by the reaction of its own radiation. For, on the electromagnetic theory of radiation as developed by Maxwell and his followers, a beam of radiant energy is supposed to have a quasi-momentum, such that if a body emits energy in a single direction it will lose momentum and, in consequence, suffer a reaction tending to push it in the opposite direction. Now if a star is at rest, and in thermal equilibrium, it follows from symmetry that it will radiate equally in all directions, and there will be no resulting impulse. If, however, the star is in motion, classical electrodynamics leads to a greater emission in the forward direction than in the backward, and consequently it would appear at first sight as though there should be a retardation which would ultimately bring the star to rest. J. Larmor found in 1912 the following expression for the resistance to motion due to radiation: $F = -vR/c^2$, where v is the velocity of the star, R the rate of emission of energy, and c the velocity of light.

The present author examines the case of a single vibrating electron radiating while in motion. He supposes an oscillator left to itself and allowed to radiate at the expense of the energy of its vibration. For this case it is found that the force exerted on the electronic vibrator by the ether inside a moving sphere (with electron at centre and radius large compared to that of the electron) is exactly equal and opposite to that due to the ether outside. Moreover, from the point of exchange of momentum, the law of conservation demands that

(Momentum lost by electron) = (Momentum gained by ether outside sphere)
—(Momentum lost by ether inside sphere).

The terms on the right-hand side (the second of which is overlooked by Larmor) annul one another. Therefore a single moving oscillator is not retarded by its radiation field, and as already noted we can generalise this result and conclude that a moving body of any size and complexity suffers no retardation as a result of its emission of radiant energy. E. H. B.

472. *Location of Sun's Magnetic Axis.* **F. H. Seares, A. van Maanen,** and **F. Ellerman.** (Nat. Acad. Sci., Proc. 4. pp. 4–9, Jan., 1918.)—Since the discovery by Hale in 1913 of the general magnetic field of the sun, regular observations were made from 1914 June 8 to Sept. 23, using three chromium lines of special suitability, λλ 5247, 5300, and 5329. Observations of the sun's field are made by placing the slit of the spectrograph in coincidence with the sun's central meridian. A compound quarter-wave plate and a Nicol prism just outside the slit serve as an analyser, the observed effect being a minute displacement of the chosen spectrum line. The amount of the displacement will vary with the inclination of the lines of force to the line of sight, *i.e.* with the position of sun's magnetic axis, the heliographic latitude of the point observed, and the distance of the observer from the plane of the sun's equator. The work was limited to the zone 45° N. to 45° S. Twelve spectrograms with exposures of 10–30 mins. constituted the normal observing programme for each day. Special precautions were taken to avoid any influence on the measurements due to prejudice concerning the plate constants. The results indicate that the magnetic axis is inclined 6·2° to the axis of rotation, and its period 31·79 days. For the reversing layer the rotation period ranges from 26·4 days at the equator to about 30·5 days at 45°. So that for latitudes below about 55° the magnetic axis in its motion about the axis of rotation appears to lag behind the reversing layer. C. P. B.

473. *East and West Asymmetry of Solar Prominences.* **J. L[armor].** (Nature, 100. p. 425, Jan. 31, 1918.)—Presuming that the solar prominences are uniformly distributed round the sun's equator, an explanation of the known east and west asymmetry is sought in the factor of their configuration with respect to the line of sight to the observer. The outer regions of the solar atmosphere rotating more rapidly than the parts below, a prominence pushed up from below might slope forwards in the direction of the sun's rotation, and would thus present a different aspect and different depth in the line of sight according as it is on the advancing or receding side of the sun. The darkness of the absorption markings on the disc would depend on the depth of material in action, while this factor would only apply in a much smaller degree to the bright prominences at the limb. C. P. B.

474. *Resonance Theory of Origin of Moon.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. 78. pp. 116–131, Dec., 1917.)—The theory that the production of a semidiurnal tide might be so greatly magnified by resonance as to lead to the rupture of the mass has been found to fail in the case of a homogeneous incompressible mass. In the present paper the author examines the influence on the result of assuming the mass to be heterogeneous. From the limited analysis possible it appears that in this case the tendency would be to increase the actual speed, and to diminish the speed needed for resonance, so that the truth of the resonance theory is considered highly probable.
C. P. B.

475. *Distribution of Mean Motions of Asteroids.* **K. Hirayama.** (Math. Phys. Soc. Tōkyō, Proc. 9. pp. 214–221, Dec., 1917.)—The number of known asteroids is now over 800, and a discussion of their mean motions confirms the existence of the gaps first pointed out by Kirkwood in 1866, when the number of recognised asteroids was only 86. In the present paper the data from the *Berliner Jahrbuch* for 1917 are examined, and the results shown in a diagram representing the distribution of the mean motions from those nearly equal to Jupiter to those four times as great. The positions and width of the gaps are also calculated to determine the accurate values; a detailed discussion is given of each group. C. P. B.

476. *Orbit of* (132) *Aethra.* **[Miss] A. E. Glancy.** (Astron. J. 31. pp. 17–20, Dec. 18, 1917.)—Attention having been drawn to the possibility that an object photographed at the Lowell Observatory on June 10, 1913, might be identical with the lost minor planet Aethra, a series of plates were taken with the photographic telescope of 64 cm. focal length and effective aperture 10 cm., at the Cordoba National Observatory, starting on Dec. 1, 1916. No moving image was detected. Search was also made on Astrographic plates with similar results, and it is therefore concluded that the Lowell object is not the missing asteroid. A discussion is given of the history of the asteroid, indicating that the orbit is very uncertain, being based on an arc of only twenty-two days. There appears to be a possibility that Aethra has been perturbed by some other asteroid larger than itself. It may have eluded re-discovery in consequence of its high inclination and eccentricity, or by reason of a large unknown variability in brightness.
C. P. B.

477. *Hodographic Treatment and Energetics of Undisturbed Planetary Motion.* **A. Gray.** (Phil. Mag. 35. pp. 181–189, Feb., 1918.)—A short account is given of the hodograph, published by Möbius in 1843, but first applied to orbital motion by Hamilton, who in 1847 showed that the hodograph for the motion of an undisturbed planet is a circle. The paper then deals with the problems of the resolution of a planetary orbital velocity into two components of constant amounts, one also in constant direction, showing how to transfer from the hodograph to the corresponding orbit. C. P. B.

478. *Absorption Effects in Spiral Nebulæ.* **H. D. Curtis.** (Nat. Acad. Sci., Proc. 3, pp. 678–682, Dec., 1917.)—Continued study of the photographs of spiral nebulæ obtained with the Crossley reflector at the Lick Observatory shows that the phenomenon of dark lanes caused by absorbing or occulting matter is very frequent, and the present note is a preliminary abstract of a more complete description soon to be published. Thirty-eight of the larger edgewise spirals show the effect very clearly, and three examples are shown in illustration. A second class consists of nebulæ whose principal plane makes a slight but appreciable angle with the line of sight, and in these the phenomenon is presented in the form of an asymmetry in the structure which is always found to be in direct relation with the major axis of the ellipse. These phenomena are possibly of similar nature to the gaps found in certain regions of our stellar system, in the Milky Way and on the fringe of diffused nebulosities. Moreover 25 spectroscopic binaries are known in which the H and K lines of calcium do not partake at all of the periodic shift shown by the other spectral lines. All but one of these stars are located in or near the Milky Way, and the phenomenon would be explained by the interposition of a cloud of invisible calcium vapour in interstellar space. Regarding the suggestion that the differences of intensity on opposite sides of the major axis might be a phase effect, it is noted that they would involve regarding the light of the spirals as due to reflection, which is negatived by the absence of polarisation, and also by the general structure of many of the nebulæ. The fact that spiral nebulæ are absent from our galaxy and very scarce near it, might be due to the presence on the periphery of occulting matter of a nature similar to that under discussion shown by the distant spirals. C. P. B.

479. *Radiative Equilibrium of the Stars.* **F. A. Lindemann.** (Observatory, No. 522. pp. 65–66, Jan., 1918.)—Writing with respect to the paper by Jeans in which the existence of a stellar photosphere is accounted for theoretically, it is suggested that if reliable data as to the density could be obtained, then the stellar parallax might be determined from consideration of the pressure-shift of the spectral lines, temperature, and apparent magnitude. Also, assuming the universe to be in a steady state, an idea of the average life-history of a star might be available from a count of the stars of different spectral types, as the number of stars of any given type at any time will be inversely proportional to the time during which the average star remains in that state. With regard to the radio-active processes in stars there seems little reason to suppose that these can be affected by temperature unless the average energy is of the same order as the energy of the radio-active reaction. C. P. B.

480. *Finite Velocity of Gravitation and Stellar Evolution.* **D. Alter.** (Lick Observat. Bull. 9. [No. 305], pp. 128–131, 1918.)—Previous investigators of this question appear generally to have assumed that the gravitational field generated at any instant radiates for all time from the point occupied by the centre of mass of the creating body at the instant of creation of the field; also that the velocity of the field away from this point is the same in all directions, irrespective of the velocity of the body. Except on the part of the relativists the conclusion has been that the velocity is either infinite or at least many times greater than that of light. The author examines the effect on problems of stellar evolution of making the somewhat different assumptions (1) that gravitation has a finite velocity (for calculations taken equal to that of light); (2) that the centre of any gravitational field is not subject to accelerations, but moves with the velocity possessed by the body at the instant of generating the field. An example of the ensuing perturbation is taken for the binary σ Aquilæ, which would result in an increase of period of 0·0032 day in 100 years. In the case of Algol the presence of the third body is disturbing, but there appears to be some evidence of change, as the *Berliner Jahrbuch* for 1787 gives a period shorter than that which Algol has at present. In the case of the solar system the effect would be too small for measurement. In a short discussion of the Michelson-Morley experiment it is suggested that first the light from the sun near the horizon should be used, and then reference made to an artificial light source. C. P. B.

481. *Masses of the Stars.* **H. N. Russell.** (Popular Astron. 25. p. 666, 1917. Nature, 100. p. 393, Jan. 17, 1918. Abstract.)—Tables are given summarising the results of calculations for the mean mass of a pair of stars, grouped according to the spectral classes of the bright components of all the double-stars for which data are available. The giant stars of all spectral classes are shown to be nearly equal in mass, as they are in brightness. Among the dwarf stars, where the luminosity decreases rapidly with increasing redness, the mean mass also decreases, but more slowly. The masses of the stars thus appear to be more closely related to the absolute magnitudes than to spectral types, the brighter stars being the more massive.

C. P. B.

482. *Spectrum of α Canum Venaticorum.* **C. C. Kiess.** (Popular Astron. 25. p. 656, 1917. Nature, 100. pp. 393–394, Jan. 17, 1918. Abstract.)—Sixty-seven photographs of the spectrum of this star have been obtained at the Detroit Observatory, and from measurements of some 200 lines the star is classed as Ap. Belopolsky found that certain lines were variable as to visibility, and that these lines were divisible into two groups. These have been verified as due to europium and terbium. Many lines not variable have been identified with the stronger lines of yttrium, lanthanum, gadolinium, and dysprosium. C. P. B.

483. *Short-period Variable RZ Cephei.* **C. Martin** and **H. C. Plummer.** (Roy. Astron. Soc., M.N. 78. pp. 156–163, Dec., 1917.)—Results are given from 50 photographs of the variable taken at Dunsink, the period being about 7·4 hours, one of the shortest known. The phase relations of this and other short-period variables are discussed in relation to those of four long-period variables, and the sun with a period of 11 years. The points of resemblance are such that some kind of common operation is suggested in stars differing so widely as RZ Cephei (period 7·4h.) and stars with a range of some 10 magnitudes and periods of the order of a year or more. The often-accepted view that the short-period variable is a spectroscopic binary may have to be changed, as has already been discussed in the case of RR Lyræ.

The small apparent changes of radial velocity may not be due to orbital motion, and it is concluded that there maybe no great reason against the view that, apart from the eclipsing systems, the great majority of variable stars manifest the operation of one essentially uniform process in Nature. C.P.B.

484. *Variations in the Fourteen-months Component of Polar Motion.* **H. Kimura.** (Roy. Astron. Soc., M.N. 78. pp. 163–167, Dec., 1917.)—The elements of the 14-months' term in polar motion are determined from the two series of observations made at Greenwich and Pulkova from 1825 to 1890 and, after this, from the observations of Albrecht and Wanach. In the resulting analysis of the periods a striking relationship is shown to the period 240 years, which the author has previously detected in the variation of sun-spot numbers. Curves are given showing the results for radius and period of the term. C. P. B.

485. *Nebulosity about Nova Persei* (1901). **F. G. Pease.** (Astron. Soc. of the Pacific, Publ., Dec., 1917. Roy. Astron. Soc. Canada, J. 12. p. 25, Jan., 1918.)—On a plate secured with the 60-in. reflector at Mt. Wilson on 1917 Sept. 19 with 10 minutes' exposure a nebulous spot was found 10″ distant from the nova, in p.a. 210°. Other plates show the nebula involved in nebulosity with strongest condensations on s.p. side. These condensations give a fan-shaped appearance to the nebulosity on that side, which resembles in many ways the nebulosity appearing in the original outburst. The above-mentioned bright knot does not appear on the 1901 photographs. Two curved wisps, concave towards the nova, lying at either side of the knot and inclined in p.a. 125°, bear a close resemblance to forms shown in 1901. Another wisp inclined in p.a. 200° extends northward, passing the nova on the preceding side. There is no certain change in the position of any of the details during the interval between these plates. C. P. B.

486. *Structure and Motions of Spiral Nebulæ.* **V. M. Slipher.** (Am. Phil. Soc., Proc. 56. pp. 403–409, 1917.)—A spectrographic study of nebulæ has been in progress at the Lowell Observatory since 1912, using a small dispersion (140Å = 1 mm. in the violet) on account of the faintness of the spectra, with exposures varying from 20 to 40 hours. The plates are measured under the Hartmann spectrocomparator in comparison with a dark-line spectrum of known velocity. The resulting velocities vary from − 300 km./sec. to + 1100 km./sec., and are tabulated for 25 of the nebulæ examined. Comparison of these measures for certain objects with the values obtained elsewhere shows good agreement. The average velocity, 570 km./sec. is about 30 times the average radial velocity of stars. The spiral nebulæ are thus in a class to themselves, and it is significant that they cluster about the poles of the Milky Way. Taking the velocities for face-view spirals, inclined spirals, and edge-view spirals, there is a systematic increase of radial velocity in the three types from 330 km./sec. to 760 km./sec. Photographs of the spectra of certain nebulæ show distinct inclination of the lines, indicating rotation of the nebular matter, and detailed investigation appears to show that the direction of rotation relative to the spiral arm is the same for all. Most of the nebulæ with positive velocities are in the region R.A. = 12h., while in the opposite portion of the sky there are several with negative velocities, on which more observations are needed. From a preliminary solution of the data acquired it appears that our stellar system is moving in the direction of R.A. = 12h.; Decl. = − 22°, with a velocity of about 700 km./sec. C. P. B.

487. *Spectrographic Study of* κ *Pegasi.* **F. Henroteau.** (Lick Observat. Bull. 9. [No. 304], pp. 120–127, 1918.)—A study of spectrograms of this visual binary taken at the Lick Observatory from 1900 to 1917 leads the author to conclude that many of the variations in intensity of the spectrum lines may be due to superposition by different amounts of the component spectra (the component whose spectrum as stronger in the H_γ region was found by Campbell in 1900 to be a spectroscopic binary). Details are given to show the variation of the orbit, an important feature being the change of the angular distance of periastron from the ascending node, indicating a rotation of the line of apsides. Comparison is made of the probable parallax deduced from velocity reductions (0·025″) with the value obtained by Flint at Washburn (0·028″). The tables showing the relative intensities of enhanced and arc lines of Ti, Mn, Fe indicate a systematic variation with the epochs of maximum and minimum velocity, but while in 1917 the star seems to have an earlier class of spectrum near maximum than it has at minimum velocity, this is reversed in the records of 1900 and 1912. The author considers this is explained by the superposition on the first spectrum of the spectrum of the second visual component, which is possibly of the same type. C. P. B.

488. *Law of Densities in Gaseous Mass.* **A. Véronnet.** (Comptes Rendus, 165. pp. 1055–1057, Dec. 24, 1917.)—Applying the laws of gases to the constitution of the sun, it is found that the conditions lead to the formation of an almost homogeneous nucleus, surrounded by an atmosphere where the density and pressure vary rapidly in geometrical progression. Diffusion of the vapours of the nucleus will condense in the atmosphere and form mists and clouds, the movements uncovering the nucleus in the spots. C. P. B.

489. *Photographic Spectra of Meteorites.* **W. Crookes.** (Roy. Soc., Phil. Trans. 217. pp. 411–430, Dec. 21, 1917.)—Working with a spectrograph specially built for laboratory investigations, having 5 double prisms of right- and left-handed quartz of the Cornu type, and lenses of 40 mm. aperture and 700 mm. focal length, with three interchangeable slits of the fixed-jaw pattern, photographs of the spectra of 30 meteorites have been obtained in the region λ2500 to λ7000. To cover this extent of spectrum eight exposures were necessary for each record. Experiments are described having for their object the estimation of the relative amounts of chromium and nickel present in various meteorites, the basis being similarity of relative line intensity when compared with the spectra of laboratory-prepared alloys of known composition. Although only approximate estimates are thus possible, it is suggested that the amount of Cr present was between 0·6 and 0·1 %. Detailed tables are given, showing the constituent lines of Ni, Cr, Mg, Si, Na, Mn, K, Al, and Cu, as they occur in the different meteorites. The most striking fact is their similarity of composition, and the small number of elements represented. Only ten elements are found, and only four of these—Fe, Cr, Mg, and Ni—are present in quantity. With three exceptions the proportions between these elements appear to be the same in all. C. P. B.

490. *Orbit and Perturbations of* (716) *Berkeley.* **F. J. Neubauer.** (Lick Observat. Bull. 9. [No. 301] pp. 111–114, 1917.)—References are given to various investigations on this minor planet since its discovery by Palisa in 1911, and a set of elements for the orbit are computed by the short method of Leuschner. The perturbations due to Jupiter are tabulated as found by the Hansen-Bohlin method. C. P. B.

491. *Orbit of* (718) *Erida.* **C. S. Mundt.** (Lick Observat. Bull. 9. [No. 302] p. 115, 1917.)—Comparisons are made between four determinations of the orbit, to show the possibility of calculating an orbit of a minor planet from one opposition which is as satisfactory for observational purposes as the result based on three oppositions. C. P. B.

492. *Nebulous Ring about Nova Persei.* **G. W. Ritchey.** (Astron. Soc. of the Pacific, Publ. Dec., 1917. Roy. Astron. Soc. Canada, J. 12. pp. 25–26, Jan. 1918.)—A negative taken with the 60-in. reflector at Mt. Wilson on 1917, Oct. 16, shows the small fan-shaped nebula described by Pease in a previous Abstract. There is also a sharp continuous ring of nebulosity about 16" diam., nearly circular, with nova at its centre. This has a large bright patch and a slight doubling in the north-east quadrant. This will be carefully watched for signs of expansion in connection with observation of increase of brightness of nova between 1917 Aug. 16–28. C. P. B.

493. *Number of Stars of each Photographic Magnitude in different Galactic Latitudes.* **P. J. van Rhijn.** (Roy. Astron. Soc., M.N. 78. pp. 132–140, Dec., 1917.)—Dividing the sky into 8 galactic zones, all the stars of determined photographic magnitude and galactic latitude between the brightest star and magnitude 15·5 are tabulated to find the average number of stars in each of the zones. The investigation is based on the final Harvard Polar Sequence. C. P. B.

494. *Galactic Coordinates.* **A. C. D. Crommelin.** (Scientia, Feb., 1918. Nature, 100. p. 473, Feb. 14, 1918. Abstract.)—In comparison with other systems it is explained that star-catalogues, giving positions with respect to a plane independent of the earth's motions, would have the great advantage of not getting out of date, only small corrections for proper motions being required. The Galaxy is naturally the most convenient reference plane fulfilling such conditions, although there is some difficulty in giving precision to its outlines. From eight determinations it is suggested that the adopted position of the north galactic pole, for equinox 1900, should be R.A. = 12h. 42m. 37s.; Decl. = + 27° 32′. An actual star could be selected as zero for galactic longitude, say α Cygni, which has an extremely small proper motion. C. P. B.

495. *Fifth Nova in Andromeda Nebula.* **G. W. Ritchey.** (Astron. Soc. of Pacific, Publ. Dec., 1917. Roy. Astron. Soc. Canada, J. 12. p. 26, Jan., 1918. Nature, 100. p. 512, Feb. 28, 1918. Abstract.)—A negative taken at Mt. Wilson with the 60-in. reflector on 1916 Oct. 16, shows another nova (the fifth now known) in the Andromeda nebula. The magnitude is about 18, distance from nucleus about 255" south and 26" west. This nova is invisible on a negative taken 1917 Sept. 17, which shows stars fainter than magnitude 20; it is also invisible on 16 earlier photographs of the nebula. The reality is confirmed by a negative taken by Shapley on 1917 Oct. 13. The last nova found by Shapley in the nebula has decreased at least 2 magnitudes within a month. C. P. B.

496. *Optical Absorption.* **P. Debye.** (Phys. Zeits. 18. pp. 428–429, Sept. 15, 1917.)—Discussion of the occurrence of atomic absorption limits and their position in relation to series spectra. [See next Abs.] C. P. B.

497. *Absorption in Spectrum of Hydrogen Stars.* **J. Hartmann.** (Phys. Zeits. 18. pp. 429–432, Sept. 15, 1917.)—Photographs of stellar spectra with well-developed hydrogen series are produced, showing the positions of absorption mentioned in Debye's note [see preceding Abs.]. C. P. B.

498. *Variations of α Orionis.* **T. W. Backhouse.** (Roy. Astron. Soc., M.N. 78. pp. 167–173, Dec., 1917.)—A tabulation is given of visual estimations of the magnitude of α Orionis from 1887 to 1917, made by Argelander's step method with comparison stars of standard magnitude. C. P. B.

499. *Meteorites and Terrestrial Eccentricity.* **J. Bosler.** (Comptes Rendus, 165. pp. 784–787, Dec. 3, 1917.)—A discussion is given of the statistical results of meteorites falling on the earth's surface, first given by H. A. Newton, who found that the majority had direct orbits inclined in general less than 35° to the ecliptic. It is concluded that the majority of cases favour a diminution of the eccentricity of the earth's orbit. [*Erratum, ibid.* p. 1124, Dec. 31, 1917.] C. P. B.

500. *Preliminary Orbit Determinations by Leuschner's Method.* **[Miss] A. E. Glancy.** (Astron. J. 31. pp. 20–21, Dec. 18, 1917.)—A method is outlined for simplifying the determination of an orbit by so preparing the observations that the times used are Greenwich mean noon or midnight, and the intervals all equal. The data for the chosen dates may either be obtained from a graph of the actual observations or by direct interpolation. C. P. B.

501. *Orbit of Spectroscopic Binary γ Phœnicis.* **R. E. Wilson.** (Lick Observat. Bull. 9. pp. 116–117, 1918.)—The elements of this interesting system are given as computed from 31 spectrograms taken during the interval 1903–1917. The orbit is nearly circular, and is the only example at present known of a late-type star moving in an orbit of such small eccentricity. The period is 193·79 days. C. P. B.

502. *Orbit of Spectroscopic Binary σ Puppis.* **R. E. Wilson.** (Lick Observat. Bull. 9. pp. 117–119, 1918.)—A new orbit is determined by combining the Cape results with those obtained by the Mills expeditions, furnishing 51 observations extending from 1904 to 1917. The period is 257·8 days and eccentricity 0·17. C. P. B.

503. *New Variable Stars.* **E. C. Pickering.** (Harvard Coll. Observat. Circ. Nos. 201, 202. Nature, 100. p. 512, Feb. 28, 1918. Abstract.)—In No. 201 details are given of 19 new variable stars discovered photographically and of two others found visually. One is of the Algol type, one with period 2·8957 days, and two others are Cepheids with periods of 0·4786 day and 0·365 day.

No. 202 gives the estimated dates during 1918 of maxima and minima of a number of long-period variables. C. P. B.

504. *Proper-motion Stars.* **M. Wolf.** (Astron. Nachr. No. 4922. Nature, 100. p. 512, Feb. 28, 1918.)—Details are given of the proper motions of 19 stars near the Andromeda nebula, and of five others near δ Arietis. A faint star in the latter group shows the large proper motion of 1·74″ per year, in the direction 180°. C. P. B.

505. *Photographic Determination of Height of Aurora.* **C. Störmer.** (Nature, 101. pp. 4–5, March 7, 1918.)—Series of simultaneous photographs of the aurora of 1917 Dec. 16, were obtained from two stations, Christiania and Aas, 28 km. from each other. The measurements give altitudes of the same order as obtained at Bossekop in 1918, about 100 km. for the lower border of rays and curtains, and also agree with observations on 1917 Feb. 15, from the same two base stations. It thus appears that the cosmic rays causing the aurora have the same penetrability as those causing the aurora in the *aurora zone*, and that the southern situation is due to systems of corpuscular currents outside the earth, which are also the cause of the accompanying magnetic storms. Further photographs are to be taken with red-sensitive plates. C. P. B.

506. *Rotation and Radial Velocity of Central Part of Andromeda Nebula.* **F. G. Pease.** (Nat. Acad. Sci., Proc. 4. pp. 21–24, Jan., 1918.)—Using the focal-plane spectrograph with the 60-in. reflector of Mt. Wilson, an exposure of 79 hours was made during 1917 Aug., Sept., and Oct. Another spectrogram was obtained by an exposure of 84 hours during 1916 Aug., Sept., and Oct. Illustrations are given showing the spectrum and the deduced velocity curve. The radial velocity of the nebula is —816 km./sec., and the linear velocity of rotation at a point 2 minutes of arc from the nucleus is 58 km./sec. C. P. B.

507. *Classification of Long-period Variable Stars.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 78. pp. 92–118, Dec., 1917.)—The classification of long-period variables suggested by the author in 1907, leading to the view that the variability might be due to the aspect of presentation of the axes of rotation, is discussed in comparison with the recent classification by Phillips [Abs. 208 (1917)], who found they could be divided into two distinct groups. C. P. B.

508. *Nova Ritchey.* **E[thel] F. Bellamy.** (Observatory, No. 522. pp. 68–65, Jan., 1918.)—Attention is drawn to a misprint in a former note [Abs. 25 (1918)] in which the designation of a star is given with wrong number. BD + 59° 2662 should be BD + 59° 2262. C. P. B.

509. *Orbit of Binary Star* Σ2026 (*B*7561). **G. C. Comstock.** (Astron. J. 81. pp. 88–86, Jan. 17, 1918.)—Comparison of published orbits for this star from 1908 to 1917 shows such disagreements that the case is evidently a difficult one. A new set of elements are given from reconsideration of all the data available, and an ephemeris is supplied for comparison with future observations up to 1982. C. P. B.

510. *Unit of Stellar Distance.* **de R. Pailhade.** (L'Astronomie, Dec., 1917. Nature, 100. p. 488, Jan. 81, 1918. Abstract.)—It is suggested that 10^{10} km. be the unit for measurements of stellar distance. The usual unit now adopted, the light-year, is equivalent to 946 of such units, while the *parsec* corresponds to 8·25 light-years, or about 8000 of the proposed units. C. P. B.

LIGHT.

511. *Focal Length of 40-inch Yerkes Refractor.* **E. E. Barnard.** (Astron. J. 31. p. 24, Dec. 18, 1917.)—Measurements with a steel tape in 1902-1908 showed that the distance from the outer surface of the crown lens to the focal plane was 746·7 in (18,966 mm.) at 50° F. ; the distance from centre of air space to focal plane was 739·9 in. (18,793 mm.) ; the focal length computed from micrometer measures of star distances is 762 in (19,354 mm.) at 50° F., this being verified from a photograph of the heliometer arc in Perseus From these results it is seen that the telescope is equal in effective power to a telescope from 1 to 2 ft. longer than is indicated by the length of the tube. C. P. B.

512. *Images on Silvered Photo-plate.* **C. W. Waggoner.** (Phys. Rev. 11. pp. 187–188, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—In silvering some mirrors on glass negatives, from which the gelatine had been removed, it was discovered that in a number of cases positive images appeared on the glass. The images appeared only when the side of the glass from which the film had been removed was silvered, and they had the appearance of faint daguerreotypes. It was at first thought that these images were due to imperfect cleaning, but treatment with various chemicals was not successful in removing them. It seems probable that the phenomenon is due to the action of gelatine on the surface of the glass. That a film of gelatine will actually tear pieces of glass from the surface on which it is placed and allowed to harden is well known to glass manufacturers, and is the process used in making the so-called "chipped glass" surfaces. The images may be accounted for by the presence of the large amount of metallic silver in the shadows on the negative, which may reduce this tearing action of the gelatine, thus leaving a smoother surface for the silver mirror. This explanation would account for the fact that the image is always a positive one. A. W.

513. *Optical Constants and Radiation Laws of Carbon.* **H. Senftleben** and [**Miss**] **E. Benedict.** (Ann. d. Physik, 54. 1. pp. 65–78, Feb. 8, 1918; Paper read before the Schles. Gesell. f. vaterl. Kultur, July, 1917.)—Describes determinations of the index of refraction n and of the absorption coefficient χ of carbon in the visible region of the spectrum. The values obtained for these quantities for wave-length $\lambda = 0{\cdot}546\,\mu$ were $n = 1{\cdot}96$ and $\chi = 0{\cdot}66$, and these values vary only slightly with the wave-length. The reflecting power R of carbon deduced from these results is 14·9 % for $\lambda = 0{\cdot}546\,\mu$. At $\lambda = 0{\cdot}436\,\mu$, $n = 1{\cdot}90$, $\chi = 0{\cdot}68$, and $R = 14{\cdot}3$ %. At $\lambda = 0{\cdot}623\,\mu$, $n = 2{\cdot}00$, $\chi = 0{\cdot}66$, and $R = 15{\cdot}3$ %. As regards the radiation law $I = \mu T^4$, where I is the total radiation at temperature T, it is shown that μ is not a constant, but is a function of the temperature of the form $(m/T) + n$. For ordinary carbon the value of μ varies from $4{\cdot}02 \times 10^{-5}$ at 1000° abs. to $4{\cdot}67 \times 10^{-5}$ at 4500° abs., but the variation is much greater at the lower temperatures than at the higher ones, where the radiation is approximately proportional to the fourth power of the absolute temperature. For graphite the corresponding values of μ are $2{\cdot}72 \times 10^{-5}$ and $3{\cdot}45 \times 10^{-5}$, and again the variation is only slight at the higher temperatures. These results are, generally speaking, in good agreement with those of other workers. [See Abs. 1852 (1912).] A. W.

514. *Optical Properties of Rubidium.* **J. B. Nathanson.** (Phys. Rev. 11. pp. 227–238, March, 1918.)—An account has previously been given [Abs. 41 (1917)] of an investigation made by the author on the reflecting powers of sodium, potassium, and rubidium. A direct method was employed, using a photoelectric cell as a photometer. The polarimetric method has been applied to sodium by Drude, and to sodium and potassium by R. W. and R. C. Duncan. The present paper gives a description of a determination of the optical properties of rubidium by this method. The Rb mirror was the same as was used in the previous work, and a right-angled prism was employed to eliminate troublesome reflections from the glass front of the mirror. The optical constants were obtained for wave-lengths ranging from 454·6 $\mu\mu$ to 640·9 $\mu\mu$. A simple Babinet compensator and two nicols were employed to measure the phase-difference and azimuth, the constants being then calculated from Drude's formulæ. The reflecting powers of the metal in contact with glass were, with the exception of that for $\lambda = 589{\cdot}3\ \mu\mu$, somewhat lower than those previously obtained by the direct photoelectric method. The results do not warrant the assumption that the coefficient of absorption of Rb remains constant irrespective of the medium in contact with the metal. A. W.

515. *Residual Rays of Rock-salt.* **H. P. Hollnagel.** (Phys. Rev. 11. pp. 135–136, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—In 1909 Rubens and the author published results on the determination of the wave-lengths of certain residual rays as obtained by an interferometer method. Since then a large number of residual-ray determinations have been made in a similar manner, taking only the first beat. It appeared that the energy distributions consisted of an intense band and a weaker satellite of greater or less wave-length. Later work by Rubens led to the conclusion that all such bands were due to water-vapour absorption for various radiations, saddling a broader band which was of the nature of a resonance curve. It seems to have become arbitrarily established that an inference curve should only include the first beat, a procedure somewhat unwarranted and conducive to misleading results. In recent experiments the author has attempted to push the curves a considerable amount further in order to decide whether the assumptions which were implied in the previous investigations are correct. Such curves extending over four or more beats have been obtained for rock-salt, and they appear to indicate that the phenomena concerned are not nearly so simple as was previously supposed. A. W.

516. *Complete Achromatisation of a Two-piece Lens.* **G. W. Moffitt.** (Phys. Rev. 11. pp. 144–147, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—Usually the achromatisation of compound lenses is dealt with in terms of partial dispersions, dispersive powers, etc. These, while depending upon the properties of the glasses for their values, are not true constants of the glasses themselves. This is not the case with the Hartmann dispersion constants, which are constants of the glasses only. The conditions for complete achromatisation of a two-glass thin lens may be concisely and exactly expressed in terms of the Hartmann constants. It is shown that for complete achromatism $l_0 = l_0'$ and also $a = a'$, l_0 and a being the quantities in the Hartmann dispersion formula $n = n_0 + c/(l - l_0)^a$. For a cemented lens the formula connecting the radii of curvature is $c/r_1 + (c' - c)/r_2 = c'/r_4$. We have, therefore, a simple method of telling at a glance whether it is possible to achromatise completely a lens of two given glasses. The statement that the partial dispersions must be proportional throughout the spectrum is now replaced by the simple statement as to the equality of the Hartmann constants. When the conditions for complete achromatism are fulfilled the ratio of the partial dispersions becomes the ratio of the constants c for the two glasses. Unless the values l_0 agree very closely it is better to compute the radii in the usual way, using the new conditions to determine which glasses will combine with the best results. In general two glasses should be used whose values of the Hartmann constant c differ as much as possible, thereby avoiding great differences in the curvature of the lens faces. A. W.

517. *Scattering of Light by Spherical Shells and by Complete Spheres of Periodic Structure, when Refractivity is Small.* **Rayleigh.** (Roy. Soc., Proc. 94. pp. 296–300, April 2, 1918.)—The problem of a small sphere of uniform optical quality has been treated in several papers ("Sci. Papers," vol. i. pp. 87, 104, 518; vol. 4. p. 397; vol. 5. p. 547; vol. 6. p. 220). In general, the calculations can be carried to an arithmetical conclusion only when the circumference of the sphere does not exceed a few wave-lengths. But when the relative refractivity is small enough, this restriction can be dispensed with, and a general result formulated.

In the present paper some former results are quoted, but the investigation is now by an improved method. It commences with the case of an infinitely thin spherical *shell,* from which the result for the complete uniform sphere is derived by integration. Afterwards application is made to a complete sphere, of which the structure is symmetrical but periodically variable along the radius—a problem of interest in connection with the colours, changing with the angle, often met with in the organic world. It seems probable that a structure of this sort is the cause of the remarkable colours, variable with the angle of observation, which are so frequent in beetles, butterflies, and feathers. E. H. B.

518. *Diffraction of Images of Circular Objects.* **M. Hamy.** (Comptes Rendus, 165. pp. 1082–1087, Dec. 31, 1917.)—An analysis is given of the diffraction of a circular object viewed at the focus of an objective covered with an opaque diaphragm with a narrow slit. The results are to be applied to the case of measurements of the solar diameter. C. P. B.

519. *Molecular Scattering of Light.* **C. Fabry.** (L'Astronomie, Jan., 1918. Nature, 100. p. 473, Feb. 14, 1918. Abstract.)—Verification has been experimentally obtained in the laboratory of the University of Marseilles of Rayleigh's explanation of the blue colouration of the sky. It is suggested that other celestial phenomena may also be due to scattering by gaseous particles. For instance, that part of the solar corona which gives a continuous spectrum may not consist of solid or liquid particles, but may be attributed to diffusion of photospheric light by molecules of truly gaseous coronal matter. Other applications of the phenomenon might be found in the varying luminosities of cometary appendages. C. P. B.

520. *The Drude Dispersion Theory from the Standpoint of Bohr's Model, and the Constitution of Hydrogen, Oxygen, and Nitrogen.* **A. Sommerfeld.** (Ann. d. Physik, 53. 15. pp. 497–550, Jan. 24, 1918.)—This paper is prefaced by a lengthy introduction in which generalities are discussed. Drude and Natanson's Valency rule is considered, namely: "the number of electrons capable of vibration (dispersion electrons) in the molecule is for a complete gas series proportional to the valency." This proportionality factor, which depends on e/m, does not agree with the kathode-ray value or that determined from the Zeeman-effect. This apparent difference is dealt with in Chap. I.

Another feature of the Valency rule discussed is the information which it affords as to the electronic structure of molecules. Debye has succeeded in deducing the dispersion observations for hydrogen from Bohr's model of the hydrogen molecule, and the present author has calculated the dispersion formula for a general Bohr molecule consisting of a ring of electrons and of positive nuclei arranged upon the axis of the ring. From this model the electronic significance of valency is found to be that the sum of the valencies of a molecule is equal to the number of their external loosely bound electrons. This rule is naturally restricted to those molecules where the Drude Valency rule finds application. Drude's expression is obtained from the general dispersion formula if the assumption be made that the electrons of the external ring are bound with equal force, *i.e.* isotropic, corresponding to Lorentz and Drude's hypothesis of the quasi-electric force. Taking account of anisotropic forces, a quantity factor has to be introduced to make the dispersion measure of e/m compatible with that given by the kathode-ray method. In Bohr's model the unions are throughout different, the electrons being therefore anisotropic. After these general considerations the author deals in Chap. I with the dispersion in a gaseous Bohr molecule. The chapter is divided into 5 sections in which are mathematically discussed: (1) The Drude dispersion theory; data for the gases H, O, N, CO_2, SO_2, H_2S and CO being introduced; (2) The dispersion formula for an electronic ring, whereby it is shown that the outer ring of a Bohr molecule consists of as many electrons as corresponds to the sum of the valencies; (3) The assumptions for isotropic unions. Comparison is here made with Drude's results, and the conclusion drawn, that the Drude theory is, from the author's standpoint, a possible but very abnormal special case, namely, isotropy; (4) Approximate values for anisotropic union; (5) Solution of the contradiction between the dispersion value of e/m and that afforded by the kathode rays.

In Chap. II the magnetic rotation of the plane of polarisation by Bohr molecules is considered in 5 sub-sections, viz.: (6) Discussion of the Drude theory of rotation dispersion; (7) The formula for the magnetic rotation of an electronic ring; (8) Other quanta expressions for the magnetic field and general principles involved therein; (9) The necessary assumptions for isotropic unions; (10) Paramagnetic installations in the magnetic field. Here the example of oxygen makes it requisite to obtain the influence of a paramagnetic orientation of the molecule in the magnetic field on the results. Lack of paramagnetism probably causes all orientations of the molecule to be equal, but its presence, according to Langevin's theory, produces with decreasing temperature an increasing preference to field directivity. The author shows that paramagnetism is a property of the atom and not of the molecule, in support of which he cites Wiedemann's law for the additive character of paramagnetism in salts and solutions. Chap. III, in 5 sub-sections, deals with the constitution of the gases H, O, and N, as follows: (11) General considerations respecting the molecular models used. Here the Drude Valency rule and the distinction between loosely bound (dispersion, valency) electrons and strongly bound ones (Röntgen or structural) leads to the following structure for H, O, and N: In hydrogen both electrons are loosely bound, in oxygen of the 8 + 8 electrons four are loose and six are strongly united to the 2 nuclei, while with nitrogen (7 + 7 electrons) six loose electrons form the outer electronic ring, 4 being firmly attached to the nuclei. With hydrogen therefore are 2 simple, with oxygen 2 double, and with nitrogen two triply-charged nuclei. In exactly the same manner as Bohr showed for the hydrogen molecule, it follows from the axial equilibrium of the electrical forces at the nuclei for the O and N molecules, that the nuclei are at a distance $a/\sqrt{3}$ (where a denotes the ring radius) from the ring plane. The present author was the first to give the O_2 and N_2 models; these are in accord with Bohr's hypothesis for the O and N atoms, namely: with 2 and 3 external loosely bound electrons respectively. The author discusses the principal objections raised against his models. The dispersion and refraction of the gases H, O, and N, and the empirical value of ω (the angular velocity) are dealt with in Section 12, while the magnetic rotation and confirmation of the empirical value of ω occupy Section 13. In (14) the author considers the relationship between the empirical and quanta theoretical values of ω. Finally in (15) the probable constitution of helium is discussed. H. H. Ho.

521. *Table of Log$_{10}$ Sec.^{2} for determining Photographic Densities by Means of Nicol Prisms.* **P. S. Helmick.** (Univ. of Iowa, Monographs, No. 4. [14 pp.], May, 1917.)—This table is intended for use with photographic density apparatus employing Nicol prisms in their construction, and gives the photographic density of the plate, namely, log$_{10}$ (Incident light/Transmitted light), directly in terms of the angle of rotation of the nicols. The value of the function is given every 0·05° from 0° to 89°, and every 0·01° from 89° to 90°, together with the tabular differences for each 0·01° for the whole range. [The Table may be obtained on request from the Librarian of the State University of Iowa, Iowa City, Iowa.] AUTHOR.

522. *Bohr's Theory of the Hydrogen Spectrum.* **J. Stark.** (Ann. d. Physik, 54. 2. pp. 111–116, Feb. 15, 1918.)—According to Bohr's theory there are only two monatomic carriers concerned in the case of the hydrogen spectrum: the positive hydrogen ion and the hydrogen atom. The positive hydrogen ion yields, according to his theory, no spectrum, while there is a series spectrum of sharp lines corresponding to the hydrogen atom. But experiments have shown that hydrogen possesses an ultra-violet continuous spectrum, the carriers for which are monatomic, and hence Bohr's theory in its present form must be rejected. Consideration of the hydrogen canal-rays and of the time effect of a magnetic field shows that the band or many-lined spectrum of hydrogen cannot have the H_2-molecules as carriers. The existence of H_2^+ rays of long duration and the association of a sharp spectrum with the H_2^+ ion is again not consistent with Bohr's model atom. [See Abs. 1411 (1915).] A. W.

523. *Origin of Spectral Series.* **H. S. Allen.** (Phys. Soc., Proc. 30. pp. 127–130; Disc., 130–131, Feb., 1918.)—This paper develops an idea put forward in an earlier one, describing an atomic model with a magnetic core. It is assumed that the principle of the constancy of angular momentum may be applied to the *total* angular momentum of the *electron* and a *certain part of the core* bearing a special relation to the electron. On the lines of Bohr's theory this leads to an expression for the oscillation frequency, which is similar to Rydberg's formula, and contains a constant which is the same for all elements. The so-called "phase" μ of a "sequence" is regarded as proportional to the angular momentum of a definite portion of the core. In observed series the phases of the two sequences are not equal to one another; consequently, whatever interpretation be given to the "phase," the

two types of state concerned must be in some ways different from one another. When the magnetic field of the core is taken into account, a formula is obtained which is identical with that of Ritz. An explanation of the series of enhanced lines in spark spectra is also suggested.

In the *discussion,* **J. W. Nicholson** thought the fundamental assumption seemed a natural one. Bohr's theory, in the case of hydrogen, assumed the angular momentum to be proportional to the integers in Balmer's series. In the case of more complex atoms we were compelled to assume that $(r + \mu)$ is the quantity to which the angular momentum is proportional. To consider this extra angular momentum to be attached to the nucleus is, of course, another assumption. It is equivalent to attaching a physical significance to tubes of force, which J. J. Thomson has tried to do. An interesting feature of the theory was that it gave the series of enhanced lines of spark spectra, and the physical interpretation of $k = 2$, viz., that these are due to atoms with another electron torn off, seemed very feasible. The fact that the nucleus might be magnetic was pointed out by Hicks, who showed that the scattering of α-particles by atoms might be accounted for by magnetons rather than electrons. E. H. B.

524. *Quantitative Spectra of Li, Rb, Cs, and Au.* **A. G. G. Leonard** and **P. Whelan.** (Roy. Dublin Soc., Proc. 15. pp. 274–278, Feb., 1918.)—Describes a continuation of the work begun by Pollok and Leonard [Abs. 1510 and 1815 (1907)] with a view to facilitating the use of the spectrograph in detecting the metallic elements when present in solution in small quantities. A single-prism quartz spectrograph was employed, the dark-slide of which is made so as to take specially thin glass photographic plates in slightly curved form, by which means the whole spectrum from λ7000 to λ2000 is received on the plate in very good focus. A condensed spark was used, the electrode containing the solution under examination being made of foil wrapped in the shape of a tube of about 1 m. bore. In some cases the electrodes were of gold, in others of copper, platinum, or silver, according to the nature of the solutions used. Tables are given of the lines observed with different solution strengths, which ranged from strong solutions down to 0·001 %.

The most persistent lines in the case of lithium are the two lines λ6708·2 and λ4602·5, which appear in 0·001 % solutions. The rubidium lines did not exhibit any remarkable persistency, only one, λ4571·8, appearing with the 0·1 % solution. With cæsium a fair number of lines were obtained, those at λλ4593·5, 4555·5, 4540·2, and 2525·8 appearing with the 0·001 % solution. Gold examined with Pt electrodes shows a good number of lines, and with Ag electrodes some lines coincident with Pt lines are revealed. The solution lines are not very persistent, no lines appearing with 0·01 % of metal in solution. The lines showing in a 0·1 % solution are λλ4792·8, 4310·7, 3927·8, 3133·2, 3122·9, 2918·5, 2676·1, 2641·6, and 2201·4. In all cases the chlorides of the metals were used. A. W.

525. *Mathematical Structure of Band Series.* II. **R. T. Birge.** (Phys. Rev. 11. pp. 136–137, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—In the first part of this paper [Abs. 1356 (1917)] a new band series formula was proposed, which had been found to hold with the greatest possible accuracy for the A_1 series of the λ3883 CN band. The author has now remeasured the entire C_1 series, from $m = 6$ to $m = 169$, and his calculations are based jointly on these measurements and those of Uhler. The portion from $m = 16$ down to $m = 6$, embracing those lines where the C_1 series, in perfect analogy with the A_1 series, merges into the corresponding doublet (C_2) series, is uncertain, and the values used show a definite divergence from any simple smooth curve. The C_1 series, apart from this portion, follows the hyperbolic law with an accuracy commensurate in every way with the A_1 series. The validity of the law therefore appears to be established, and seems to furnish evidence of the nature of the fundamental field of force of the molecule. This fundamental field, at certain distinct points, is noticeably disturbed, causing the regular "perturbations." These, while in general equal in number and similarly situated in the five singlet series of this band (as Uhler has pointed out), increase in magnitude from the A_1 to the E_1 series, having values as large as 0·1 Å.U. in the C_1 series. Besides the lines (about 20) forming the perturbations, all lines of the C_1 series between the first regular perturbation at $m = 85$ and the seventh at $m = 148$, show an interesting systematic deviation from the hyperbolic law. The observed frequency-differences, outside of the perturbations, all lie on a hyperbola identical with that used in the computations, but shifted 0·001 Å.U. nearer the *m* axis. A. W.

526. *Absorption Bands in the Spectra of the Uranyl Salts.* **H. L. Howes.** (Phys. Rev. 11. pp. 143–144, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—In their study of the uranyl double chlorides Nichols and the author found it possible to reverse a complete group of fluorescence bands lying between λ5080 and λ4880. The present work was undertaken to extend this reversing region towards the red. A theory of luminescent radiation recently proposed by Kennard lent interest to the investigation. Difficulties were encountered owing to the fact that the crystals are of a greenish-yellow colour, necessitating the use of crystals of increasingly thicker layers to bring out the dimmer absorption bands as the light admitted is changed from blue to yellow. Orange or yellow screens had to be used in addition. The rôle played by the new bands discovered in producing fluorescence is a minor one, because they are excessively dim. No doubt if special crystals of great size and exceptional clearness were formed the bands would appear stronger, and more bands could be discovered. The present work has added the reversals of two complete groups to the original group mentioned. For some reason the bands cannot be traced as far into the red when the crystal is cooled to −185° C. It is evident that Stokes' law does not hold, and it may be that every fluorescence band has an absorption band of the same wave-length. A. W.

527. *Fluorescence of Certain Uranyl Salts.* [Miss] **F. G. Wick.** (Phys. Rev. 11. pp. 121–129, Feb., 1918.)—A careful study of the fluorescence spectra of a number of the uranyl salts at room temperature made by Nichols and Merritt [Abs. 858 (1912)] showed certain common characteristics with regard to the location, relative intensity, and shape of the bands. The present work includes a study of the relative intensities of the bands, determinations of the shape of a few bands which show partial resolution at room temperature, and measurements of the positions of the crests of the bands of a large number of salts. The instrument used was a Hilger constant-deviation spectrometer provided with a Lummer-Brodhun cube and two collimators. The results obtained are in agreement with those obtained by Nichols and Merritt for the salts observed by them. The fluorescence bands form a series with a frequency interval which is practically uniform for a given salt. Absorption bands appear to be a continuation of the fluorescence bands, but with a shorter

interval. The two series of bands overlap, and certain bands in the violet reversing region appear as absorption or fluorescence bands, according to the conditions of illumination. In the extreme red and violet bands of all the salts observed there is some variation from the uniform interval, which may be explained by the fact that these bands are dim, and, in the violet region, the absorption overlaps the fluorescence and makes the position of the crest less distinct. The interval is not the same for all the salts, but there appears to be a uniformity in the interval for a given group of salts. In the case of the bands which show partial resolution at room temperature, intensity measurements were made at intervals of 5 or 10 Å.U. In most cases it was found that there is not exact coincidence between the position of the lines and the maxima of the intensity curve, but there appears to be some indication that the lines of the resolved spectrum may have some relation to the irregularities of the curves. Speaking generally, it appears that the characteristics of some of the salts observed by Nichols and Merritt, with regard to number of bands, their distribution, and relative intensity, are common to all. The spectra of the salts differ in that the intervals between the bands vary and the energy curve is shifted in position for different groups of salts. The degree of resolution at room temperature also varies, and it appears that the double salts of highest molecular weight show the highest degree of resolution. A. W.

528. *Absorption-laws for X-rays.* **R. Glocker** (Phys. Zeits. 19. pp. 66–72, Feb. 15, 1918.)—It has been shown by Kossel and Siegbahn [Abs. 1674 and 1052 (1915)] that the absorption coefficient of every chemical element varies with the wave-length of the X-radiation (homogeneous) according to a linear law, except at certain wave-lengths where the element shows selective absorption. Here there is a discontinuity. Thus for the complete description of the absorptive properties of any substance the following information is necessary: (1) The wave-lengths at which selective absorption occurs; (2) the numerical value of the two constants in the equation connecting log μ with log λ, for the spectrum ranges between the points of selective absorption; (3) the magnitude of the displacement at these points of selective reflection (*i.e.* the shift at the points of discontinuity in the log μ, log λ curve).

From the experimental results of various physicists (Barkla, Hull-Rice, etc.), the author has calculated these constants in the case of numerous elements, deducing in addition several interesting physical constants. A. B. W.

529. *Photoelectric Action of X-rays.* **O. W. Richardson.** (Roy. Soc., Proc. 94. pp. 269–280, April 2, 1918.)—In 1912 the author [Abs. 488 (1913)] showed that Einstein's photoelectric equation $\frac{1}{2}mv^2 = h\nu - w$ followed directly from Planck's radiation formula. Einstein deduced the equation on the supposition that the energy of radiation was distributed in discrete quanta, but the author shows that it must have a wider basis. Barkla (Bakerian Lecture, 1916) has deduced data on the electron emission especially associated with the emission of the K series of fluorescent X-radiations, from which he concludes that "there is no evidence of absorption of X-radiation in whole quanta, though the conditions are such as to give an approximation to this." The author now discusses the question theoretically in the light of his own results and those of other experimenters. He summarises his main conclusions as follows:—(1) The ratio E_K/E_λ of the energy E^K emitted in the form of K secondary X-radiation to the energy E_λ of the primary radiation (wave-length λ) absorbed is found, in the case of bromine, to be expressed to within the degree of accuracy of the observations by the formula $E_\infty/E_\lambda = \lambda/[(1+p)\lambda_K]$, where $p = \epsilon^{-0.46(\lambda_{K_\gamma}-\lambda)/\lambda}$, λ_K is the average wave-length of the K-radiations, and λ_{K_γ} is the wave-length of the shortest K-radiation. (2) The formula implies, or, at any rate, can be so interpreted as to imply, the emission of one electron for every quantum ($h\nu$) of primary radiation absorbed. It likewise involves, for the emission of each quantum of K-radiation, the absorption of one quantum of primary radiation when $\nu = \infty$, of two quanta of primary radiation if $\nu = \nu_{K_\gamma}$, the limiting frequency (threshold frequency) for excitation, and of amounts of primary energy varying between one and two quanta for exciting radiations of intermediate frequency. (3) Inasmuch as the formulæ have been deduced, and have been given a plausible explanation, on the hypothesis that the primary radiation is absorbed in whole quanta, it does not appear that the facts under consideration can be held to support the contrary hypothesis. A. B. W.

530. *X-ray Spectra and the Constitution of the Atom.* **L. Vegard.** (Phil. Mag. 35. pp. 293–326, April, 1918.)—A theoretical paper in which the work of Bohr [see Abs. 1930 (1913)] and Sommerfeld [Ann. d. Physik, 51. pp. 1–125, (1916)] is discussed and analysed carefully. The importance of Moseley's work [Abs. 467 and 1249 (1914)], on the high-frequency spectra of the elements is considered and is shown to give very strong support to Rutherford's atomic model. The author from this standpoint proceeds to apply Bohr's conceptions to the high-frequency spectra of the elements. The origin of the K, L, and M series is considered in detail from a mathematical point of view, good agreement between the theoretical and observed frequencies for various elements being obtained. The investigation leads to the result that the K-series should be attached to a ring with a "quant-number" 1 next to the nucleus and containing 8 electrons. The L-series should be due to two rings with quant-numbers 2 and consisting of 7 and 8 electrons. The M-series should probably have rings with a quant-number 3 and 9–10 electrons.

A graphical representation of these conclusions is an interesting feature of the paper. This diagram shows how the K, L, M, N, etc. series successively appear with increasing atomic weight and consequent increase of electron rings.

The paper concludes with a discussion of the following questions: (1) The electron affinity of the elements; (2) electric conductivity; (3) electron systems and radio-activity. A. B. W.

531. *Optics of the Reflection of X-rays at Crystalline Surfaces.* II. **H. Seemann.** (Ann. d. Physik. 53. 14. pp. 461–491, Jan. 15, 1918.)—A mathematical discussion, illustrated by actual X-ray spectrum photographs, of the "optics" of the reflection of X-ray beams from crystals. The following cases are considered: *A. Homocentric Beams.*—(1) "Centre" or "focus" of the convergent beam at the surface of the crystal. The cases of a "point" and a "line" focus are both treated. (2) "Focus" of beam outside the crystal. The spectral lines in these cases are shown to be hyperbolæ. *B. Astigmatic Beams.*—A description is given of a specially designed X-ray tube which can be employed for the production of X-ray beams that are approximately astigmatic. A. B. W.

532. *Continuous Spectrum of Hydrogen Canal-rays.* **J. Stark, M. Görcke** and **M. Arndt.** (Ann. d. Physik, 54. 2. pp. 81–110, Feb. 15, 1918.)—Describes further work on the ultra-violet continuous spectrum of hydrogen canal-rays [Abs. 688 (1917)]. Intensity measurements of this spectrum show that

from λ400 to λ240 μμ the intensity increases, especially in the region from λ280 to λ240 μμ, where it increases rapidly. The intensity distribution in the continuous spectrum of hydrogen canal-rays is independent of their velocity. Nitrogen canal-rays in nitrogen and oxygen canal-rays in oxygen for a kathode-fall of 800 to 8000 volts give no ultra-violet continuous spectrum of intensity even one-tenth that of hydrogen under the same conditions. Hydrogen canal-rays in oxygen give a continuous spectrum whose intensity is as great as that given by hydrogen canal-rays in hydrogen. Nitrogen canal-rays in hydrogen with a kathode-fall of 8500 volts cause the hydrogen series lines to be emitted strongly, without exciting the continuous hydrogen spectrum to any noticeable extent. The intensity of the continuous spectrum with increased gas pressure and decreased kathode-fall is relatively greater than that of the series spectrum. The above results show that the continuous spectrum is a definite property of hydrogen itself, and it appears that the carrier for this spectrum is the neutral hydrogen atom, or else the hydrogen "*Quantenpaar,*" as Stark calls the H + ion-electron. The experimental results correspond with the latter alternative. The continuous spectrum, given by the hydrogen canal-rays and by the positive column in hydrogen, and the ultra-violet continuous absorption spectrum of hydrogen, correspond to one another in so far as they have the same carriers and occur at the same time as the hydrogen series spectrum. A. W.

533. *On a Stable Crystal Lattice.* **R. Schachenmeier.** (Ann. d. Physik, 54. 1. pp. 61–64, Feb. 8, 1918.)—In this brief notice the author deals with errors contained in his previous communication on the above subject. [See Abs. 142 (1918).] The chief mistake has been a false value for the energy density. The mathematical corrections thereby necessitated are now worked out for revision of the principal paper. H. H. Ho.

RADIO-ACTIVITY.

534. *Solubility of Radium Sulphate.* **S. C. Lind, J. E. Underwood, and C. F. Whittemore.** (Am. Chem. Soc., J. 40. pp. 465–472, March, 1918.)—In the recovery of radium from its ores by various processes, radium is at some stage always precipitated, together with barium, as sulphate. The completeness of this precipitation involves relationships not only of great practical but also of considerable theoretical importance.

Measurements have been made of solutions prepared both by dissolving radium sulphate and also by precipitating it from solution. The quantity of radium sulphate in solution was determined directly by employing the "emanation" method for the Ra itself. Tables are given showing the solubility in various strengths of H_2SO_4 and in water. For 50 % acid solution of H_2SO_4, or any weaker solution, the solubility is practically the same as that in water, viz. $2{\cdot}0 \times 10^{-8}$ gm. $RaSO_4$ per cm.^{3} at 25° C. An increase of about 50 % of this value was observed on increasing the temperature to 35° C. Excess of sulphuric acid does not have any repressive effect on the solubility of radium and sulphate. The value given above is that predicted from comparison with the decreasing solubilities of calcium, strontium, and barium sulphates.

On increasing the concentration of sulphuric acid *above* 65 %, a marked rise in solubility of $RaSO_4$ takes place, and it is more than 12 times as soluble in 70 % as in 65 % acid. A. B. W.

HEAT.

535. *An Aneroid Calorimeter for Specific and Latent Heats.* **N. S. Osborne.** (Bureau of Standards, Bull. 15. pp. 133–157 [Sci. Papers, No. 301], 1917.)—A detailed description is given of the construction of a calorimeter especially designed for the determination of the specific and latent heats of substances in general use as refrigerating media. The apparatus is adapted for use between − 50° and + 50° C., and for pressures up to 70 atmos. in experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapour. The calorimeter is of the unstirred type, the heat being distributed through the contents by conduction, which process is facilitated by a system of radial metal vanes. The heating coil is located in the central axis of the cylindrical shell so that irregularities in the distribution of heat may be subdued before affecting the surface.

A Pt-resistance thermometer is employed for measuring the initial and final temperatures when the calorimeter and its contents are in thermal equilibrium.

Heat from other sources is excluded by enveloping the calorimeter with a metal jacket separated from it by an air space and, during measurements, keeping this jacket at the same temperature as the calorimeter surface, using multiple thermo-couples to indicate this equality.

Various items of the equipment are described in detail. E. G.

536. *Registering Differential Dilatometer.* **P. Chevenard.** (Rev. de Mét. 14. pp. 610–640, Sept.–Oct., 1917.)—A fuller account of the apparatus described in Abs. 969 (1917) together with the more complete results obtained when applied to the determination of the dilatation of various carbon and alloy steels [see Abs. 1189 (1917)]. L. H. W.

537. *Thermal Leakage and Calorimeter Design.* **W. P. White.** (Am. Chem. Soc., J. 40. pp. 379–393, Feb., 1918.)—The paper is a discussion of the part played by convection in the interchange of heat between a calorimeter and its environment. It is shown that if convection is reduced to a minimum by employing a suitable width of air-gap around the calorimeter, the leakage is very nearly proportional to the temperature-difference between the emitting and receiving surfaces. Convection when it occurs under ordinary calorimetric conditions is more nearly proportional to the square of the temperature-difference. Diminishing the width of the air-gap around the calorimeter diminishes convection very rapidly, and this can be carried far enough to be effectual without too great an increase of the total thermal leakage, which is then mainly due to conduction, and therefore increases about in inverse proportion to the gap width. Gaps of from 1 cm. to 1·7 cm., according to circumstances, are best with ordinary calorimeters. In adiabatic work there is little fear of convection, hence either very large temperature intervals or very large air-gaps can be profitably employed. Very thin reflecting shields around the calorimeter may be used so as to diminish radiation and thus decrease the total thermal leakage without increasing convection. E. G.

538. *Thermal Expansion of Steels at High Temperatures.* **K. Honda.** (Tôhoku Univ., Sci. Reports, 6. pp. 208–212, Nov., 1917. Eleventh Report of the

Alloys Research Inst.)—The thermal expansions of thirteen steels containing from 0·0 to 1·5 % carbon have been measured at temperatures from that of the room up to just beyond the A*c*3 point. Curves showing the elongation per unit length as a function of the temperature are all similar in form, each possessing a distinct temperature hysteresis in the critical range. Swedish iron shows no trace of the A1 transformation, while the A2 change is scarcely observable in any of the steels. The A3 transformation is marked by a gradual contraction on heating and a gradual elongation on cooling. In a 0·14 % carbon steel the A1 change becomes distinctly visible. The total contraction due to the A1 and A3 transformations reaches a maximum in the 0·81 % carbon steel. Coefficient of expansion-temperature curves show that for all steels the coefficient of expansion rises rapidly with rise of temperature until it attains a maximum somewhere in the region of the transformation ranges. The observation that the change of length at the A2 transformation is almost nil is confirmed by experiments on nickel, which showed no abnormality at its A2 point, viz. about 370° C. Tests were also made on a number of high-speed and alloy tool-steels. In the high-speed steels the A3 change occurs at about 850° C. on heating and about 100 deg. C. lower on cooling. Since these steels contain no free cementite, no A1 change-point can be observed.

F. C. A. H. L.

539. *A New Formula for the Temperature Variation of the Specific Heat of Hydrogen.* **E. C. Kemble.** (Phys. Rev. 11. pp. 156–158, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—The author, applying a recent method of Planck to the older form of the quantum theory, derives the expression for the rotational specific heat of a diatomic gas,

$$C_v = \frac{Nk}{J}\left[\frac{Q_3}{Q_1} - \left(\frac{Q_2}{Q_1}\right)^2\right], \text{ where}$$

$$Q_1 = \sum_{n=1}(2n+1)e^{-a_n/T}, \quad Q_2 = \sum_{n=1}^{\infty}(2n+1)a_n e^{-a_n/T},$$

$$Q_3 = \sum_{n=1}^{\infty}(2n+1)a_n^2 e^{-a_n/T},$$

$$a_n T = \frac{nh\nu}{2k} y_n (1 - y_n^2).$$

ν is the frequency of vibration of the atoms along their line of centres; y_n is the ratio of the frequency of rotation to the frequency of vibration. A. F.

540. *The Heat Capacity of Electro-positive Metals and the Thermal Energy of Free Electrons.* **G. N. Lewis, E. D. Eastman,** and **W. H. Rodebush.** (Nat. Acad. Sci., Proc. 4. pp. 25–35, Feb., 1918.)—The authors have determined, over a wide range of temperature, the specific heat of potassium, sodium, magnesium, and calcium. They find that in all cases the specific heat at higher temperatures is greater than that corresponding with the smooth curve which fits the values at low temperatures; and at any one temperature the deviation is greater for calcium than for magnesium, and greater for potassium than for sodium. In the opinion of the authors these differences between the heat capacity observed and that calculated from the regular curve which fits the experimental curve at low temperatures, may be regarded as representing the actual heat capacity of their more loosely bound

electrons. Whether these electrons are "free" in the sense that each electron occupies a position symmetrical with respect to two or more atoms, or whether they remain attached to individual atoms, we should expect them to add to the heat capacity of the substance, provided that they are held by sufficiently weak constraints. Many of the properties of metals pronouncedly electropositive in character indicate a high degree of electronic freedom. This forms, therefore, a new method of investigating the freedom of electrons in a metal. A. F.

541. *Comparison of High-temperature Scales.* **E. P. Hyde** and **W. E. Forsythe.** (Phys. Rev. 11. pp. 139–141, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—When comparing the results of high-temperature measurements by different authors there is much uncertainty concerning the scale used. The present paper gives the results of an intercomparison of the temperature scales of the Bureau of Standards, the Physical Laboratory of the University of Wisconsin, the Research Laboratory of the General Electric Co., and the Nela Research Laboratory. The comparison was carried out through measurements made on several tungsten filament lamps sent out by the Nela Research Laboratory. In each of the laboratories the temperature was measured by means of a Holborn-Kurlbaum optical pyrometer, using red glass as the monochromatic screen. As the different laboratories used a red glass having a slightly different effective wave-length, a small correction was necessary to reduce the temperatures to the same wave-length. Tables are given of the final results, reduced to the same value for the melting-point of palladium. A. W.

542. *Some Problems in the Theory of Radiation.* **A. Schuster.** (Roy. Soc., Proc. 94. pp. 281–291, April 2, 1918.)—This paper deals with the oscillatory energy taken up by a simple resonator under the action of white light, and the translatory energy imparted to a molecule by radiation. The first problem has already been treated by Planck: it is solved here in a very simple manner, and the method used, when applied to the second problem, leads to the important result that a molecule at rest within an enclosure of uniform temperature will, under the action of the radiations, be set in motion with an acceleration that will increase its speed until the average energy reaches a definite value. If the Rayleigh-Jeans laws of radiation be assumed to hold, the ultimate average energy due to radiation alone is two-thirds of that derived from the kinetic theory of gases. The connection between radiation and absorption is illustrated in a discussion of a pendulum acted on by a succession of blows. The author then deals with the method of treating white light as a series of impulses, a method first suggested by Gouy and favourably commented on by Rayleigh. A non-homogeneous radiation is completely defined by the distribution of energy, which—when resolved spectroscopically—is contained within a definite range of frequencies. It is shown that when a disturbance is analysed spectroscopically, the energy per unit volume and unit range of frequency is connected with the impulse ET by the relation: $U = NE^2T^2/2\pi$, where E is the e.m.f. and N the number of equal impulses. Following this is a determination of the ultimate average energy of an electric oscillator under the action of light-impulses. This in the case of an oscillator having 3 degrees of freedom is equal to the translatory energy of a molecule in accordance with the law of equi-partition. A comparison is made between the author's mode of treatment and that given by Planck. Both assume the intensity distribution to be uniform within the effective range of wave-length, and the result is

therefore not affected by considering it to remain uniform throughout the spectrum. Planck, starting from homogeneous oscillations, has to calculate the result of each within the narrow limits of frequencies closely adjoining that of the free period of the oscillator. He thus obtains the resulting energy by integration. The author avoids the integration by starting from the integrated light disturbance which, in the case of a disturbance having uniform intensity along a frequency spectrum, consists of a series of impulses within each of which the electric force is constant. The mechanical effect on the oscillator as a whole that is due to the magnetic force carried by the impulse is next dealt with; the kinetic energy of the molecule is found to tend to become equal to two-thirds of that obtained by the kinetic theory of gases, and equal to one-third of the energy of internal motion. Following this comes a determination of the retarding force acting on the moving resonator. It appears that the distribution of energy between the internal and external energy depends on the forces regulating the internal motion, but no reasonable law for these forces can be given that would lead to an exact equi-partition. H. H. Ho.

543. *The Entropy Diagram for Petrol.* **J. Rey.** (Comptes Rendus, 166. pp. 887–890, March 4, 1918.)—The use of petrol in vapour form in numerous types of mechanism has rendered desirable more exact data respecting the physical laws controlling its vaporisation. These are expressed in an entropy diagram constructed for ordinary petrol of density 0·80 to 0·82. The author has verified the specific heat to conform to the expression $C = a + bt$ (t being the centigrade temperature). The average constants have been obtained for a series of petrols of like density, namely, $C = 0{\cdot}50 + 0{\cdot}0007t^{\circ}$. The value of the molecular heat of vaporisation has been determined by comparison with the known organic liquids chloroform, acetone, carbon disulphide, and carbon tetrachloride. By tracing curves for L/T as a function of the absolute pressure, this is found to be of the form $L/T = a/T - b$. Under atmospheric pressure Bingham's formula, $L/T_0 = 17 + 0{\cdot}011T_0$, determines the molecular heat of vaporisation at the ebullition temperature T_0 for a numerous series of organic liquids, while for ordinary petrol the relation $L/T = 15160/T - 12{\cdot}42$ is found to hold. The entropy of ordinary liquid petrol (formula $C_{13}H_{26}$) is given by the expression $S_{\text{liq.}} = 0{\cdot}3089L_n\,(T/273) + 0{\cdot}007\,(T - 273)$. The entropy of the saturated vapour is given by $S_{\text{vap.}} = 0{\cdot}8089\,L_n\,(T/273) + 0{\cdot}0007T + 82{\cdot}4/T - 0{\cdot}2586$. By the aid of these formulæ the entropy diagram has been constructed. Brief details are given of an apparatus for determining the heat of vaporisation and the vapour tension of ordinary petrol. From the vapour tension curve the author has deduced the following expression: $T = 1{\cdot}167\,T_0 - 0{\cdot}641\,(T_0 - 273)$, where T represents the absolute ebullition value of the petrol as a function of T_0, the absolute boiling-point of water under the same pressure. The entropy diagram has been verified experimentally as far as 40 kg. pressure. An inspection of the diagram shows immediately: (1) that the saturated vapour of ordinary petrol is superheated by expansion; (2) that the heat of the liquid is always much more elevated than the heat of vaporisation. From these two properties, which are the reverse of those of water, it results that by expansion the saturated vapour of petrol is superheated at the same time as it performs mechanical work. By expanding liquid petrol under pressure, it vaporises partially, and, if the expansion is sufficiently prolonged, the vapour is superheated. The author opines that like properties are probably true for the principal hydrocarbons. H. H. Ho.

544. *Dependence of the Thomson-Joule Effect for Air on Pressure and Temperature for Pressures up to* 150 *Atmospheres and Temperatures from* — 55° to + 250° C. **F. Noell.** (Zeits. Vereines Deutsch. Ing. 62. pp. 49–54, Feb. 2, and pp. 63–67, Feb. 9, 1918.)—The temperature change which a gas experiences by expansion without doing external work, *i.e.* the Thomson and Joule effect, is a phenomenon first observed by Thomson and Joule but only for moderate pressures and a small temperate range. A systematic investigation has been commenced by E. Vogel at the Munich Polytechnic Institute and participated in by the authors, employing much wider limits. All previous work on the subject had been so arranged that passage from a given high pressure to that of the atmosphere was made by a reducing valve whose low-pressure side communicated with the atmosphere. In this way it was not possible to measure the cooling effect at various pressures, and so study its dependence upon pressure and temperature. The innovations to the method now described in the paper provided for the adjustment of pressure differences on both sides of the reducing valve. The apparatus is discussed at great length and diagrammatically illustrated ; the temperature measurements were made by means of a Pt-resistance thermometer. Following this comes a full description of the experimental procedure accompanied by 9 tables of results, the data being obtained at — 84°, — 55·4°, — 0·6°, 49·2°, 99·3°, 149·7°, 199·3°, and 249·9° C. respectively. The interpretation of the results occupies the second communication to which 7 curves are attached.

The experiments have firmly established the dependence upon pressure and temperature of the Thomson-Joule effect for air between the above temperature limits. The general result may be expressed by the formula :—

$$\Delta = dT/dp = \frac{A_1 - A_2 p}{T} + \frac{B_1 - B_2 p}{T^2} + \frac{C_1 - C_2 p,}{T^3} + D_1 - D_2 p,$$

where Δ is the cooling for 1 atmo. pressure-change, T the absolute temperature of the gas at the high-pressure side, p the arithmetic mean of the pressures on the high and low sides, dp the pressure difference, dT the corresponding temperature-difference, and A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2 constants. At all temperatures investigated a linear decline of the cooling effect with the pressure was found. From the experimental result as expressed by the above formula the temperature drop caused by the reducing valve can be calculated for higher initial pressures by integration and has been depicted graphically, whereby it is seen that the proportionality of the cooling with the pressure difference at low temperatures and high pressures is no longer so exact. The results of this investigation agree with those of others. By extrapolation, a portion of the inverse curve has been determined. From the observed cooling effect the specific heat of air, C_p, was calculated for the region of the experiments with confirmation of the values obtained by Scheel and Heuse and by Swann for 1 atmosphere. H. H. Ho.

545. *Formula for the Tension of the Saturated Vapour of a Monatomic Liquid.* **E. Ariès.** (Comptes Rendus, 166. pp. 193–197, Feb. 4, 1918.)—The tension of saturated vapour for any liquid when the equation of state is taken as $p = RT/(\nu - \alpha) - K/T^n(\nu + \beta)^2$, α, β, and their sum ν being assumed functions of the temperature, is given by the system: $x = \tau^{n+1}\nu/\nu_c$, $\pi = \tau^{n+2}Z/x$. These two equations are connected to each other by the Clausius table. The calculation of the tension and of a saturated vapour at any temperature whatever, only requires therefore a knowledge of the exponent n, the function ν/ν_c, and the critical constants P_c and T_c, the latter permitting the passage from the reduced temperature τ or from the reduced tension π to the absolute temperature T or to the tension P expressed in atmospheres, respectively. The exponent n, which has previously been found common to all monatomic bodies, is equal to $\frac{1}{2}$, and the object of the present note is to demonstrate that there exists for all these bodies a single function ν/ν_c, this being expressed by the aid of the reduced variable τ, which establishes at one and the same time that the tension of the saturated vapour for monatomic bodies satisfies the law of corresponding states. The tensions of the saturated vapours of krypton, xenon, and argon, observed at different temperatures and recorded in a previous paper, serve to calculate for each body and at each observation temperature the value of the unknown function ν/ν_c which should satisfy the above system of 2 equations. The values thus obtained show that: (1) For a given reduced temperature, ν/ν_c has sensibly the same value for all three elements (law of corresponding states); (2) this value, which is in the neighbourhood of unity at the lowest temperatures observed, but greater than unity (1·09 for xenon), decreases as the temperature increases, passes through unity at the reduced temperature $\tau = 0{\cdot}84$, and reverts back to unity at the critical temperature ($\tau = 1$). The above results lead to the formula : $\nu/\nu_c = +(1-\tau)(0{\cdot}84-\tau)/(A\tau^3+B)$, where the value is unity for $\tau = 0{\cdot}84$ and $\tau = 1$. For monatomic elements where $n = \frac{1}{2}$ and the constants have been determined by means of the previous tables, the formulæ giving the saturated vapour tension become : $x = \left(1 + \frac{(1-\tau)(0{\cdot}84-\tau)}{2\tau^3+1{\cdot}20}\right)\tau^{3/2}$, $\pi = \tau^{5/2}Z/x$. New tables have been constructed from these formulæ for krypton, xenon, and argon. The paper concludes with a discussion of the results for these elements. H. H. Ho.

546. *Critical Constants of Mercury.* **E. Ariès.** (Comptes Rendus, 166. pp. 334–337, Feb. 25, 1918.)—Krypton, xenon, and argon are not the only monatomic bodies whose vapour tensions have been observed over a long range of the thermometric scale, since mercury has been examined as far as 880° C., where it possesess a vapour tension of 162 atmos. The critical tensions of mercury, which are yet unknown, should in consequence be very high, and exceed the data obtained in previous experiments on the critical constants. Reference is made to a formula proposed by the author in a previous communication [see preceding Abs.], which applies to all monatomic bodies, and which affords values approaching those of the critical constants of mercury, The requisite data are derived from the system : $x = (\gamma/\gamma_c)\tau/^{3/2}$, $\pi = \tau^{5/2}Z/x$, or $\pi = (\gamma_c/\gamma)\tau Z$. Denoting γ/γ_c of the variable τ by Γ, the following relation was obtained : $\Gamma\gamma/\gamma_c = 1 + [(1-\tau)(0{\cdot}84-\tau)]/(2\tau^3+1{\cdot}20)$. It is further deduced that $P_2T_1/P_1T_2 = Z_2\Gamma_1/Z_{12}\Gamma$, where Γ and T_2 are two temperatures, P_1, P_2 the corresponding pressures. Applying the latter formula to the tension of saturated mercury vapour, which is 50 atmos. at 700° C. and 162 atmos. at 880° C. the following relation is obtained :—

$$\frac{Z_2\Gamma_1}{Z_1\Gamma_2} = \frac{162(273+700)}{50(273+880)} = 2{\cdot}734.$$

If T_c were known, τ_1 and τ_2 would follow, and the numerical value of the latter relation, which is only a function of τ_1 and τ_2, could be calculated. Conversely, by assuming the above expression to be true, the author has calculated the critical temperature of mercury to be 1350° abs., or 1077° C. This value is supported by calculations made from other experimental data, so that the validity of the above formula is established. Tables of data are given in the paper. At the critical temperature of 1077° C. the pressure is found to be 420 atmos. H. H. Ho.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

547. *Electromagnetic Induction and Relative Motion.* II. **S. J. Barnett.** (Nat. Acad. Sci., Proc. 4. pp. 49–51, Feb., 1918.)—If a cylindrical condenser is placed in a uniform magnetic field with the lines of induction parallel to its axis, and is short-circuited and rotated, together with the short-circuiting wire, about this axis, it becomes charged to a p.d. equal to the motional e.m.f. in the wire, or the rate at which the wire cuts magnetic flux. If, however, the condenser and wire are fixed and the agent producing the magnetic field rotates, the relative motion being the same as before, the condenser does not become charged, as was proved by precise experiment in 1912. [See Abs. 210 (1913)].

The present investigation was undertaken with the hope of shedding light upon the case of translatory motion. The result appears to support the following statement: If the ether exists, the electric intensity produced by the motion of the tubes of induction in the ether between the condenser plates would be equal and opposite to the field intensity there due to the p.d.'s produced by the e.m.f. in the short-circuiting wire, and *there would thus be no charge on the lower condenser plate,* which assumes the existence of the ether and seems inconsistent with the principle of relativity. E. H. B.

548. *Magnetic and Electric Fields due to Rotation of a Conducting Sphere.* **W. F. G. Swann.** (Terrest. Magn. 22. pp. 149–163, Dec., 1917.)—The agencies considered are (1) effects of centrifugal acceleration on the electrons; (2) effects of gravity on the electrons; (3) effects of a temperature gradient on the sphere. All three have proved capable of calculation without the introduction of much of a speculative nature. It is almost immediately obvious that their order of magnitude will be too small for them to play any appreciable part in the explanation of the earth's magnetism; but the calculation of the fields is of interest simply as a problem in physics. It is easily seen that the balancing of any pair of effects will not appreciably affect the remaining one. This greatly simplifies the calculations, since the complete solutions will be obtained by adding the three solutions obtained for each effect acting alone. The calculations are made in the first place for specific inductive capacity unity, and it is then shown that the magnetic and electric forces may be obtained for any value of K, from the corresponding results for $K = 1$, by simply multiplying the latter by the factor $3/(K+2)$.

G. W. DE T.

549. *Size and Shape of the Electron.* **A. H. Compton.** (Washington Acad. Sci., J. 8. pp. 1–11, Jan. 4, 1918.)—The radius of a spherical electron, obtained from its kinetic energy assumed to be identical with its magnetic energy, must be about 10^{-13} cm., and is therefore small enough to be considered as a point-charge, even in the case of the shortest γ-rays. Therefore, if N be the number of electrons per gm. contributing to the scattering of the energy of an electromagnetic wave incident upon an absorbing medium, the fraction of energy incident on an electron which is scattered by it will be $8\pi/3 . e^4/m^2c^4$; where c is the velocity of light, giving a mass absorption coefficient due to scattering of the primary beam given by the equation $\sigma/\rho = 8\pi e^4 N/3m^2c^4$. There may be a distinct absorption due to other causes, and, in the case of the larger waves, the rays scattered by different electrons in the atom may be nearly enough in the same phase to give rise to "excess scattering," but if the electron act as a point-charge, no possible grouping of the electrons can, according to classical theory, result in a smaller absorption. Yet, for wave-lengths less than 2×10^{-9} cm. the absorptions observed are considerably less, falling as low as one-fifth as great for the shortest γ-rays. Moreover, Soddy and Russell [Abs. 1252 (1910)] and Ishino [Abs. 234 (1917)] have shown that for these shortest rays the energy scattered by different elements is accurately proportional to their atomic numbers, and therefore to the number of electrons outside the nuclei, so that the electrons must be responsible for practically all the scattering, and for these wave-lengths they must act independently of each other. Thus the electron cannot be considered as a point-charge, and the author shows that, to account for the small absorption, the electron must have an effective radius of about $2{\cdot}3 \times 10^{-10}$ cm. Obviously, electromagnetic theory will not account for the electromagnetic mass of an electron on the basis of a uniform electric distribution over the surface of a sphere of any such radius. But much the same effect, so far as the scattering of γ-rays is concerned, results from a conception of the electron as a ring of electricity of diameter comparable with the wave-length of the incident beam, and Davisson [Phys. Rev. 9. p. 570, 1917] and Webster [Abs. 1298 (1917)] have shown this to be compatible with electromagnetic theory. Approximate calculations indicate the probability that the scattering may be completely accounted for on the hypothesis of a ring distribution with a radius of about 2×10^{-10} cm., and capable of rotation about any axis, the latter supposition being requisite to account for the observed fact that the emergent scattered radiation is more intense than the incident radiation. It is worthy of note that the hypothesis further gives a satisfactory explanation of the effect observed by Forman [Abs. 442 (1916)] of the magnetisation of iron upon its absorption coefficient, hitherto unexplained, as the author has shown that Forman's explanation, that it is due to molecular orientation, is inadequate. The author claims that the fact that Forman's result can be accounted for by orientation of the electrons, tends to confirm the conclusion arrived at by Rognley and himself [Abs. 566 (1918)] that it is not the atom, but the electron itself, that is the ultimate magnetic particle. G. W. DE T.

550. *Maxwell's Equations and Atomic Radiation.* **T. Wereide.** (Ann. d. Physik, 54. 4. pp. 323–324, March 1, 1918.)—The present note is supplementary to a previous paper [see Abs. 653 (1917)], and intended to remove certain difficulties. The energy of an electron moving in a given electrostatic field consists of 3 parts: (1) the electric energy of the external field; (2) the electric energy of the electronic field; (3) the kinetic (*i.e.* magnetic) energy of the electron. The electric masses conditioning the external field are assumed at rest, and if the electron moves, in a given time-element, perpendicular to the lines of force, then the magnitudes of the above energies would remain unchanged, except for the possibility that in the outer field a scattering of energy occurs in the form of electric oscillations. The author had previously asserted, and now maintains, that such a scattering of energy does not take place. It is otherwise, however, when the electron does not move perpendicular to the lines of force of the external field. In this case there is an energy transfer between 1 and 3 above, which in consequence can give rise to a scattering of energy. The author maintains that a circular electronic motion is not equivalent to the resultants of its linear motion components. H. H. Ho.

DISCHARGE AND OSCILLATIONS.

551. *Nature of Gaseous Ions.* **L. B. Loeb.** (Frank. Inst., J. 184. pp. 775–804, Dec., 1917.)—The paper consists of a critical discussion in considerable detail, supplemented by an extensive bibliography, of the three theories which have been propounded for the constitution of gaseous ions:—(1) The labile cluster theory; (2) The stable cluster theory; (3) The single molecule theory. The discussion naturally hinges on the agreement or otherwise of results derived from the various theories of these three types, with experimental measurements of ionic mobilities under varying conditions. It is shown that (1) encounters serious difficulties in accounting for (*a*) independent mobilities and the value of the ratio of the magnetic field strength to the pressure, (*b*) the reluctance of electrons to form ions with ordinary molecules, and (*c*) the absence of intermediate types of ions to be anticipated from the growth of an ion into a drop in condensation experiments. Objection (*b*) applies in an enhanced degree to the assumption of stable clusters, of stability sufficient to withstand the disruptive action of fields with high values of the ratio of magnetic field strength to pressure. All the single-molecule theories give mobilities five or ten times too high except that of Wellisch [Abs. 1278 (1909)], and his equation includes as factor an expression which, the author shows, implicitly involves the formation of stable clusters. A similar factor occurs in all the single molecule theories except that of Sutherland [Abs. 1781 (1909)]. This theory requires, it is true, the introduction of an arbitrary constant in order to make it yield the true mobilities of the ions. On the other hand, it accounts for the temperature variation of mobility found by Phillips [Abs. 1755 (1906)], predicts the Kaufmann law of the relations between the mobilities and the molecular weights of the gases in which the ions move, and appears to be open to no serious objection. Moreover, it appears to account well for some of the more fundamental laws of ionic behaviour, and is well adapted to expansion as the knowledge of the structure of molecules advances.

G. W. DE T.

552. *Ionisation Potential of Mercury Vapour.* **T. C. Hebb.** (Phys. Rev. 11. pp. 170–179, March, 1918.)—The results of Davis and Goucher [Abs. 1278 (1917)] and of Bishop seem to prove the correctness of the suggestion of van der Bijl that the apparent ionisation of mercury vapour when bombarded with electrons possessing a velocity of 4·9 volts, as observed by Franck and Hertz and by Newman, was due to the photoelectric action of the radiation of wave-length $\lambda = 2536{\cdot}7$ acting on the receiving plate of the ionisation chamber. But neither the suggestion nor the experimental results explain the result obtained by Hebb, that the complete spectrum of mercury vapour appeared at 4·9 volts, and that an arc struck at that voltage [Abs. 778 (1917)]. Further experiments have confirmed this result, and show also that an arc could be caused to strike at any potential above 4·9 volts by varying some or all of the following factors: (i) the temperature of the kathode; (ii) the temperature of the furnace used to heat the central part of the discharge tube; (iii) the distance between the anode and kathode; and (iv) the pressure. The striking of the arc at 4·9 volts depends on the density of the electron stream, and the density and purity of the mercury vapour. If there is the slightest trace of a foreign gas present, then, even though other conditions are favourable, the arc will not strike as low as 4·9 volts. Some interesting results were obtained regarding the formation of striations in the heated tube. The results of the special ionisation experiments show, again, that in order to get ionisation of

mercury vapour at 4·9 volts it is necessary to have the vapour absolutely pure. If any photoelectric action due to the radiation $\lambda = 2536{\cdot}7$ does occur, the magnitude of such an effect with the apparatus employed could only have been small compared with the ionisation currents obtained. A. W.

553. *Elasticity of Impact of Electrons with Gas Molecules.* **J. M. Benade** and **K. T. Compton.** (Phys. Rev. 11. pp. 184–202, March, 1918.)—A method is developed for measuring the average fraction of the energy lost by an electron at a collision with a gas molecule for impact velocities less than the minimum ionising velocity. This method can only be applied to a study of those gases in which the amounts of energy lost are relatively small and in which no appreciable amount of ionisation is produced, within the range of pressures, distances, and applied potentials used, by any agency except the impacts of the electrons. Collisions of electrons with helium atoms appear to be perfectly elastic for velocities less than the velocity corresponding to 20 volts. If any energy is lost by an electron in addition to that transferred to kinetic energy of translation of the atom, such a loss is certainly less than 0·02 % of the energy before impact. From this it seems proper to conclude that: (*a*) The constituents of a helium atom are held so firmly together that they are not appreciably displaced, relative to each other, when the atom is struck by an electron whose velocity is less than the ionising velocity; or, if such displacement does occur, the natural frequency of the displaced parts must be so high that there is no appreciable lag between their motion and that of the approaching or receding electron. (*b*) There is no "minimum radiating potential" below the ionising potential of 20 volts. The only appreciable effect of the passage of the electrons through the gas is slightly to increase the mean kinetic energy of the atoms and thus slightly increase the ordinary heat radiation. The same effect on the radiation from the gas could be produced by warming it. Collisions of electrons with molecules of hydrogen and oxygen are much less elastic than in the case of helium, and the loss of energy is of a more complicated type, to which the method employed in the case of helium cannot be applied. It should be of great interest to apply the method to a study of the other inert gases and to mercury vapour. [See Abs. 64 and 96 (1917).] A. W.

554. *The Quenched Spark.* **V. Pieck.** (Ann. d. Physik, 54. 3. pp. 197–244, Feb. 22, 1918. Abstract of Dissertation, Göttingen.)—Describes an elaborate investigation of the phenomena associated with the quenched spark. The results obtained show that the quenching effect increases with higher gas pressure and greater spark-length, but the rate of increase of the effect with spark-length and gas pressure gets less and less as the spark-length increases and the gas pressure is raised. The effect is approximately the same in air, CO_2, and nitrogen, and is decidedly better in hydrogen. Experiments on the effect of the material constituting the electrodes showed that the nature of the material has a considerable influence. Much greater quenching effect was obtained with magnesium electrodes than with silver electrodes in nitrogen. The shape of the electrodes, whether rods or plates, has also a decided effect, and curves are given illustrating the variation between the results with two plate electrodes, two rod electrodes, or one rod and one plate. The effect of varying the frequency of the oscillations was investigated in air and in hydrogen, and it was found in both gases that the quenching effect was greater for short waves than for long waves at the lower gas pressures used. With the higher pressures there was little difference between the two. The

latter part of the paper gives a theoretical discussion of the subject, with special reference to the experimental results obtained. A. W.

555. *Gliding Brush Discharges.* **M. Toepler.** (Ann. d. Physik, 53. 11. pp. 217–284, Nov. 27, 1917.)—A study of photographic figures produced by high-potential discharges from an electrode placed upon the film of a photographic plate backed with tin-foil. The palm-like fronds of the negative discharge are shown to consist of luminous threads of constant thickness, the latter being 0·02 cm. at atmospheric pressure. The outlying fronds or brushes are connected with the central one by stalks indicating a lower resistance. The central brush has a diameter having a linear relation with the discharge potential. The total length of the discharge is proportional to the fourth power of the discharge potential. The length of the connecting stalks is proportional to the square-root of the thickness of the plate. The length of the luminous threads is proportional to the discharge potential. Six plates are appended. [See Abs. 954 (1908).] E. E. F.

556. *Equipotential Surfaces in the Positive Light Column of the Glow Discharge.* **H. Salinger.** (Ann. d. Physik, 54. 4. pp. 296–322, March 1, 1918.)—The apparatus employed is fully described and illustrated diagrammatically. Curves are also given showing the results obtained in nitrogen, air, and oxygen. It is found that from the axis of a cylindrical discharge tube to its walls there is a fall of several volts in the potential. Thus the walls have negative potential as compared with the axis. This "cross tension" increases with a decrease in either current or pressure. If the gas shows striations, then the "cross tension" is greatest in the layers of light and smallest in front of the heads of these layers. The equipotential surfaces are somewhat less concave to the anode than are the front surfaces of the striations. There are free positive charges in the whole of the positive column. Negative charges are found distributed in ring formation near the walls of the tube by the side of the light layers as well as (with higher pressures) before the anode and, in some cases, in the dark spaces between the striæ. The current density cannot be calculated as the quotient of the current strength by the cross-section of the column of light. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

557. *Relation between Electrical and Thermal Conductivities of Metals.* **S. Weber.** (Ann. d. Physik, 54. 3. pp. 165–181, Feb. 22, 1918.)—An application of Knudsen's method [see Abs. 899 (1911)] to the determination of the relationship between the electrical and thermal conductivities of a metal. Experiments on a tungsten filament *in vacuo* gave for the thermal conductivity the value 0·888 gm. cal. per cm. deg. From this the value of κ/σ is found to be 786×10^{-8}, where κ is the thermal and σ the electrical conductivity. According to the Lorenz law the ratio $\kappa/\sigma T$ should be constant, but a comparison of the above value with that found by Langmuir at 2200° K. shows that this function possesses a temperature coefficient which agrees well with that found by Jaeger and Diesselhorst. Further experiments are described on the physical constants of tungsten and platinum filaments at low temperatures. J. W. T. W.

558. *Thermoelectric Force, Peltier Heat and Thomson Heat under Pressure.* **P. W. Bridgman.** (Am. Acad., Proc. 53. pp. 269–386, March, 1918.)—This paper gives measurements of the thermoelectric force of couples consisting

of two branches of the same metal, one being subjected to a hydrostatic pressure varying up to 12,000 kg./cm.^{2} and the other at normal atmospheric pressure. The temperature of one junction is maintained at 0° C. while the other varies up to 100° C. Twenty pure metals and the alloys manganin and constantan were investigated. The thermoelectric force is regarded as positive when the current flows from the uncompressed to the compressed metal at the hot junction. The values of the Peltier and Thomson heats are deduced from the equations connecting thermoelectric force and temperature by the usual thermodynamic reasoning. The Peltier heat is considered positive if there is an absorption of heat when the positive current flows from the uncompressed to the compressed metal. The Thomson heat is considered positive if there is an absorption of heat when the positive current flows from cold to hot metal. Tables of results and curves for all the metals investigated are given in the paper.

The general effect of pressure on the thermoelectric force is positive. Exceptions are manganin, Mg, and Co, in which the effect is wholly negative over the range investigated, while for Fe, Al, and Sn it is negative over part of the range. The greatest e.m.f. observed is $+710 \times 10^{-6}$ volt for Bi, and the least $-20{\cdot}6 \times 10^{-6}$ volt for Sn. There are four cases of negative Peltier heat under pressure, namely: manganin, Sn, Mg, and Co. The range of values is from $+2960 \times 10^{-6}$ joule per coulomb for Bi to $-90{\cdot}5 \times 10^{-6}$ for Co. The Thomson heat under pressure is usually positive, Co, Fe, and Bi being the only exceptions. The range of values is from $+220 \times 10^{-8}$ joule per coulomb per 1 deg. C. for Zn to -280×10^{-8} for Bi. Lead under compression (100° C. and 12,000 kg./cm.^{2}) gives a value $+20{\cdot}1 \times 10^{-8}$. Wagner, working up to pressures of 800 kg./cm.^{2} has found for lead $5{\cdot}6 \times 10^{-12}$ volt per degree per kg. from 0° to 100° C. The author's interpolated value for this range is $5{\cdot}2 + 10^{-12}$. The author considers the Thomson heat of uncompressed lead to be not rigorously zero, but too small to be measured conveniently. The question as to whether the Thomson heat depends on the temperature gradient was studied in the case of Hg, but no such gradient effect could be observed. The effect of tension on the thermoelectric properties of some of the metals was also investigated. The results are complex, but in general the pure volume effect on thermoelectric quality is different according as the volume change is brought about by hydrostatic pressure or tension. The change in electrical resistance [Abs. 1010 (1917)] is determined primarily by the change in volume whether produced by tension or hydrostatic pressure. There is apparently little connection between the change of thermoelectric properties and other physical properties under pressure. There is almost exact parallelism between the pressure effect on thermal e.m.f. and on Peltier heat. The pressure effect on Thomson heat is somewhat similar to that on electrical resistance.

Although the effects are so complex, they are probably to be explained by the varying nature of the field of force surrounding the atom when the materials are subjected to such pressures. L. L.

559. *Measurement of E.M.F.'s.* **F. Wenner, P. D. Foote,** and **E. E. Weibel.** (El. World, 71. pp. 559-560, March 16, 1918.)—Describes two simple methods for the accurate measurement of e.m.f.'s. The methods are specially applicable to the determination of temperatures by means of thermocouples, the measurement of potential drops across resistance standards and shunts, etc. The methods differ from the one devised by Northrup [El. Rev. and West. Electn. 70. p. 98, 1916] mainly in that the balance is indicated

by zero change in the deflection of the millivoltmeter used, on closing a key, rather than by a zero deflection. In the first method the millivoltmeter is arranged in series with a variable resistance A and a slide wire B. A battery, in series with a second resistance C, is connected to one end of the slide wire and to a second point along the wire. The thermo-couple whose e.m.f. is required is placed as a shunt across the terminals of the millivoltmeter, and a key in this shunt circuit may be opened or closed at will. When the resistances are adjusted so that there is no change in the reading of the millivoltmeter on opening or closing the key, no current passes through the thermo-couple, and consequently its resistance does not affect the reading of the millivoltmeter. Convenient values for the resistances are A, 50 ohms; B, 5 ohms; C, 50 ohms.

In the second method the millivoltmeter S forms one of the arms (CD) of a Wheatstone bridge ABCD. The corresponding arm R is a slide wire, and the thermo-couple is connected through a key to a point along R (BC) and to the point D. Current from a shunted battery flows through the bridge from A to C, and is adjusted so that the p.d. across the millivoltmeter is greater than the e.m.f. of the thermo-couple. When the contact on the slide wire R is adjusted so that there is no change in the reading of the millivoltmeter on closing the thermo-couple key, no current flows in the thermocouple and hence its e.m.f. is equal to the drop in potential between D (or B) and the sliding contact, and may be read directly from the position of the sliding contact. The millivoltmeter should be reliable, at the reading used, to an accuracy a little higher than that sought in the temperature measurements. A. W.

560. *Vibration Galvanometer for Low Frequencies.* **H. Schering** and **R. Schmidt**. (Zeits. Instrumentenk. 38. pp. 1–11, Jan., 1918. From the Physikal.-Techn. Reichsanstalt.)—Describes a new form of vibration galvanometer which can be used over a very wide range of frequencies and in which the tuning, being electromagnetic, is very easily controlled. [See also Abs. 1461 (1915).] J. W. T. W.

561. *Selenium Rectifier.* **H. Greinacher**. (Archives des Sciences, 44. pp. 472–475, Dec., 1917. Paper read before the Soc. Suisse de Physique.)—If a direct current is sent through a Se cell, and an alternating current is then superimposed upon the direct-current, the latter is increased. An alternating-current only produces a direct component when it ceases to be sinusoidal. The author attributes both effects to the variation of resistance of Se with the voltage, which he assumes to be a linear relation [see, however, Abs. 1260 (1912)]. He gives a theory of the rectification, and deduces the value $KV^2/W(1 - KP)^2$ for the rectified current, where V is the effective a.c. voltage, P the original d.c. voltage, K the coefficient of the voltage effect, and W the resistance of the selenium cell at voltage P. The author exhibited a battery capable of furnishing a continuous voltage of 6000 when fed by an alternating current [see Abs. 589 (1917)]. E. E. F.

562. *New Standard of Current and Potential.* **C. T. Allcutt**. (Am.I.E.E., Proc. 37. pp. 83–89, Feb., 1918.)—The proposed standard is essentially a Wheatstone bridge which will balance for but one value of current. There are three constant resistances, and a fourth one whose resistance is a function of the current flowing through it. In practice this latter consists of a fine filament of a material having a relatively high temperature coefficient of resistance, the filament being enclosed in an evacuated glass bulb. It is

possible to obtain resistances in this manner the values of which change very rapidly with currents of a few milliamps. Platinum filaments and others of Wollaston wire have been used. The standard is said to be reliable within 0·1 %. F. E. S.

563. *Anode Complications in the Silver Voltameter.* **J. Obata.** (Math. Phys. Soc., Tōkyō, Proc. 9. pp. 246–254, March, 1918.)—The heavy anode liquid may contain an excess of colloidal silver which will result in an excess of silver being deposited on the kathode. If this be so, then in those voltameters containing no septum between the anode and kathode, such as the Smith form, a greater deposit of silver should be obtained than in those forms containing a septum. The magnitude of such an error was the primary object of this research. The results are summarised below :—

Experiment.	Deposit in Smith Form *less* the Deposit in Richards Form (Porous Cup).	
	(*a*) Fine-grained Cup.	(*b*) Open-grained Cup.
1	$0{\cdot}001_5$ per cent.	0·001 per cent.
2	$0{\cdot}003_6$ „	—
3	$-0{\cdot}001_0$ „	$-0{\cdot}001_3$ „
4	$0{\cdot}007_3$ „	—
5	$0{\cdot}002_5$ „	$-0{\cdot}001_5$ „
6	$-0{\cdot}001_1$ „	—
7	$0{\cdot}001_9$ „	$0{\cdot}000_5$ „

The author concludes from these results that a difference between the two forms is established. It was found, however, that when the Richards form was used the acidity of the electrolyte increased, whereas with the Smith form it remained constant. The results when corrected as if the acidity had been throughout that found at the end show a difference even smaller than that given in the table. The author concludes, however, that the error caused by the anode liquid is certainly about 2 parts in 100 000. [The reason why the acidity increased in the Richards form is not explained.] F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

564. *Magnetisation of Iron in the Absence of Hysteresis.* **W. R. Wright.** (Phys. Rev. 11. pp. 161–169, March, 1918.)—In general, two methods have been adopted for suppressing hysteresis—mechanical shocks or vibrations and an alternating magnetic field, either transverse or longitudinal. Finzi, Ashworth [Abs. 1185 (1914)], and Steinhaus and Gumlich used alternating fields, superimposed on the magnetising field. Ashworth alone investigated the change of magnetisation with temperature, but his results were distorted by the alternating field which was present in the specimen. Steinhaus and Gumlich avoided this distortion by reducing the alternating field to zero before observing the magnetisation produced in the specimen due to the applied magnetising field. The work here described is a repetition of Ashworth's work, using the method of Steinhaus and Gumlich. Five specimens were made in the form of ellipsoids of revolution, and these formed a series of steels with decreasing carbon content, whose last member approximated to pure iron. A null method was employed with the magnetometer used. Curves were obtained showing how the anhysteretic magnetisation varies with temperature. The magnetisation curves for a particular specimen are uniformly concave to the H-axis and do not intersect each other except at the origin. The most pronounced feature of the curves is the abnormally high susceptibility for low magnetising fields, which persists up to the immediate neighbourhood of the transformation-point. The results appear to show that the magnetisation for a given field, in the absence of hysteresis, always decreases with a rise in temperature. The magnetisation-temperature curves show that the effect of carbon is to produce two irregularities, one just above 700° C. and the other in the neighbourhood of 200° C. The former corresponds to the precipitation of the carbides which occurs at the eutectoid point. The latter is due to the magnetic transformation of the cementite in the steel. It also appears that the equation proposed by Fröhlich does not fit the anhysteretic isothermal magnetisation curves and that the equation, even when modified as Ashworth proposed, does not give the magnetisation properly related to the temperature. A. W.

565. *Change in the Electrical Resistance of Tellurium in a Transverse Magnetic Field.* **B. Beckman.** (Ann. d. Physik, 54. 3. pp. 182–196, Feb. 22, 1918.)—The material used in this research was pure Te supplied by Kahlbaum, cast into small cylindrical rods, 10–15 mm. long and 1·4–1·8 mm. in diameter. The resistivity of the specimens varied from 0·05 to 0·3 ohm-cm. according to the rate of cooling in preparation. The homogeneity of the cylinders was tested by measuring the resistance between knife-edges movable in the direction of the axis of the cylinder. The field strengths employed varied up to about 11,000 c.g.s. units and the observations were made at a temperature of 17° C. The results are given for 12 specimens in a series of tables, a d.c. method being employed to measure the resistance. In all cases except two, $\Delta R/R = \gamma H^2$; ΔR is the increment of resistance R in the transverse magnetic field H. The constant γ varies from $8·58 \times 10^{-11}$ to $9·04 \times 10^{-11}$, increasing linearly with the resistivity of the specimen. In two cases the data are represented by $\Delta R/R = \gamma H^2 + \delta H^4$ ($\delta = -2·2 \times 10^{-20}$ and $-5·5 \times 10^{-20}$). Some measurements of the resistance change were also made when alternating current was employed. Outside the field the d.c. resistance differs from the a.c. resistance. With frequency 2600 $(R_{a.c.} - R_{d.c.})/R_{d.c.}$ varies from $-3·0 \times 10^{-8}$ to $-9·2 \times 10^{-8}$. In a field of 10,200 c.g.s. units $(\Delta R_{a.c.} - \Delta R_{d.c.})/R_{d.c.}$ was 7×10^{-5}. Observations on the same specimen a month later gave 8×10^{-5}. Heurlinger [Abs. 1078 (1916)] has given a theory of this difference of resistance-change in terms of the coefficients of the transverse thermomagnetic and galvanomagnetic effects, and has supported it by experimental evidence in the case of Te. The constants used, however, were not all obtained on the same specimen of Te. Wold [Abs. 612 (1916)] has determined the constants on the same Te plate, but owing to the varied heat-treatment during the measurements the data cannot be satisfactorily employed to test Heurlinger's theory. L. L.

566. *Nature of the Ultimate Magnetic Particle.* **A. H. Compton** and **O. Rognley.** (Phys. Rev. 11. pp. 132–134, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—If the ultimate magnetic particles are groups of atoms, magnetisation should be accompanied by a translation of the atoms—a hypothesis which has been disproved by K. T. Compton and E. A. Trousdale, who showed that the Laue diffraction pattern obtained through a magnetic crystal is not affected by magnetisation. If these particles are the atoms themselves, the orientation due to magnetisation should change the position of the electrons of which the atoms are composed. In virtue of the fact that the intensity of a beam of X-rays reflected from a crystal face depends upon the arrangement of the electrons in the atoms which make up the crystal, such a shift of the electrons should make itself known by changing the intensity of this reflected X-ray beam. Careful experiments by a null method carried out with a crystal of magnetite failed to detect any variation of intensity of the reflected beam of X-rays when the reflecting crystal was magnetised, although calculation shows that a displacement of the atoms of 1/200th of the distance between the atoms would have produced a noticeable change in the intensity of the reflected beam. This negative result therefore confirms the conclusion of Compton and Trousdale that since the atoms are not appreciably displaced the molecular magnets cannot be groups of atoms. Similar difficulties are encountered on the hypothesis that it is the atoms which are the ultimate magnetic particles. With an atom of the Bohr type, a change in the intensity of reflection as great as 500 % should occur in the higher orders when the crystal is magnetised. With the more symmetrical arrangement suggested by Hull for the iron atom a change of some 80 % would be expected if the atom is turned around by the magnetic field. The authors conclude that it is neither a group of atoms, such as the chemical molecule, nor the atom itself, which constitutes the elementary magnet. We must look rather to the atomic nucleus, as suggested by Merritt, or to the electron, as proposed by Parson, for the ultimate magnetic particle.

A. W.

567. *Diurnal Changes of Earth's Magnetism.* **S. Chapman.** (Observatory, No. 522. pp. 52–60, Jan., 1918.)—A discussion is given of the evolution of the theory attributing the diurnal changes of the earth's magnetism to the action of electric currents, principally situated above the earth's surface, but to some extent flowing within the earth. The known facts with respect to the phase of the variations indicate that these may be produced by the solar radiation received by the sunlit portions of the earth. Further investigation is necessary to determine the order of magnitude and actual type of the magnetic variations, which are being examined in relation to other terrestrial atmospheric circulation phenomena.

C. P. B.

568. *Dependence of Internal Terrestrial Magnetic Field on Induced Currents.* **[Miss] A. van Vleuten.** (K. Akad. Amsterdam, Proc. 20. 8. pp. 861–864, 1918.)—New computations are made on the plan given by Steiner in 1912, using Fritsche's latest values for the potential coefficients of the diurnal variation, and the regularities in the terms of higher order are found to be in favour of the idea formulated by Schuster in 1889 concerning the induced-current origin of diurnal magnetic variations ; but the principal terms do not correspond to the theory, and this indicates that the cause of the diurnal variation cannot be ascribed solely to a system of currents exterior to the earth and currents within the earth induced by the former system.

C. P. B.

569. *Do the Forces causing Diurnal Variation of Terrestrial Magnetism Possess a Potential?* **[Miss] A. van Vleuten.** (K. Akad. Amsterdam, Proc. 20. 8. pp. 858–860, 1918.)—According to the Gaussian theory the potential of the terrestrial magnetic field is determined when we know either (1) the north component over the surface, or the east component over the surface, and (2) the values of the force directed north along a curve joining the two poles. As in this case the forces are those causing the diurnal variation, hence completely periodical, the east component on the surface alone is sufficient to determine the potential. Data for ten stations have been analysed, with the conclusion that the forces causing the daily variation, taken as a whole, do *not* possess a potential, although it always remains possible to deduce part of these forces from a potential. C. P. B.

570. *Magnetic Survey of New Zealand.* **C. C. Farr.** (Nature, 100. pp. 453–454, Feb. 7, 1918. Abstract.)—Observational work extended over the years 1899–1909, in the course of which 384 stations were occupied. Particulars are given of position, date of observation, values of declination, dip, east and north components, horizontal, vertical, and total forces. Reductions to common epoch were based on magnetograph data obtained at Christchurch from 1901 onwards, and observations at repeat stations. Results are also shown on maps dealing with the various elements. Large disturbed areas in Stewart Island, and near Invercargill and Dunedin receive special attention and comparisons with the geological formations. C. P. B.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

571. *Practical Radiology in the Army.* **R. Desplats** and **R. Wickham.** (Archives d'Él. Médicale, 26. pp. 67–78, Feb., 1918.)—Dausset has described a method for the localisation of projectiles by means of a limited rotation and, at the same time, a variable lateral displacement of the tube parallel to the table, which can be employed with a nearly closed diaphragm. Its principal advantage seems to be the ease with which small, barely visible particles can be localised in thick regions of the body. There are, however, several disadvantages, and the method here described claims to have all the advantages of Dausset's plan without its inconveniences. The principle of the method, the application with this method of the variable rotation of the tube, and the localisation of the depths of projectiles with respect to a posterior mark are dealt with in detail; the two former being illustrated diagrammatically. A. E. G.

572. *A Portable Röntgen-ray Generating Outfit.* **W. D. Coolidge** and **C. N. Moore.** (Gen. Él. Rev. 21. pp. 60–67, Jan., 1918.)—Various systems were investigated, and ultimately a gasoline-electric set, furnishing alternating current to a step-up transformer, with a self-rectifying X-ray tube operating directly from the latter, is selected. The separate elements comprising the outfit are described in detail and a complete wiring diagram given. The advantages of the outfit here described may be summarised as follows: (1) Simplicity of apparatus. (2) High efficiency with consequent light weight and portability. (3) No moving parts other than the gasoline-electric set. (4) Control of line voltage, making it possible to duplicate electrical conditions and X-ray results very accurately. (5) The tube has been designed to carry all of the energy that the generator can deliver. For this reason no harm can be done to the tube by raising the filament current too high. Under such conditions the milliamperage will go up, but the voltage will decrease, so that the energy delivered to the tube will not go up appreciably. (6) The gasoline-electric set can be placed at any desired distance from the high-tension part of the outfit, so as to avoid noise in the operating room. (7) No storage battery to get out of order. (8) Engine can be made to idle at very low speed, conducive to long life. This advantage comes from the use of the voltage governor instead of a speed governor. (9) An accidental short-circuit of the generator does no harm; it simply lowers the line voltage to such an extent that the field excitation goes down, the ignition fails and the engine stops.

Certain improvements could be made by special design. These are briefly discussed. [See also Abs. 415 (1918).] A. E. G.

573. *Region of Greatest Therapeutical Effect in the Ultra-violet Spectrum.* **C. A. Schunck.** (Röntgen Soc., J. 14. pp. 24–26; Disc., 26–28, Jan., 1918.)—The author has previously come to the conclusion that the radiations of greatest therapeutic value lie between λ3000, near the limit of the solar spectrum at λ2980, and λ1850 the limit due to strong atmospheric absorption even in thicknesses of a few cm., the ultra-violet spectrum extending from about λ3900 to λ1850 [see Abs. 816 (1917)]. Experiments have since been made in the endeavour to ascertain which are the most effective radiations therapeutically in this region as judged by the erythema produced on the skin, which medical opinion considers measures the clinical efficiency of the radiations in question. By protecting the skin when exposed to the tungsten arc with a 1-mm. thickness of glass which absorbs all radiations shorter than λ2950, it was shown that no reaction took place, whereas with a piece of microscopic cover-glass that cut off the radiations at λ2750, there was a slight reaction in one experiment. In this manner it was arrived at that radiations above λ3000 in the ultra-violet had no therapeutic value under the conditions in which the experiments were made. By passing the light through varying thicknesses and strengths of copper sulphate solution and by exposures of 2 minutes with the tungsten arc lamp at 8 amps. there is no reaction at λ2900, a slight reaction from λ2800 to λ2600, and a good one from λ2500 to λ2400. The erythema at λ2400 is about the same intensity as with the tungsten arc alone which was used as a control experiment; the solutions are enclosed in a glass tube with quartz ends: the length of the tube can be varied, and it is interposed between the cylindrical lens and the skin. These results show that there is an increased effect with decrease of wave-length, the maximum commencing at λ2500, but they are open to the objection that the effect may be cumulative from λ2900, due to the gradual increase of transmitted radiations as λ2400 is approached. This point is investigated further and, so far, the experiments show an increase of effectiveness with decrease of wave-length, especially from λ2500 downwards; whether there is a distinct maximum region has still to be ascertained. Turrell thinks that the erythema may be induced by a movement of electrons in the superficial tissues (to which the action is localised) in the form of a bombardment—an electronic effect. If this interpretation is correct, then the wave-energy absorbed by the superficial tissues is converted into the energy of the moving photoelectric electrons and they act in such a manner as to dilate or obstruct the smaller vessels and allow the blood to escape and diffuse through the superficial tissues, which in simple language is what happens in an erythema and in which, it is considered, lies the main curative effect. In the *discussion*, **S. Russ** questioned the range λ2540 to λ2880 as being the most effective, arguing that too much attention has been given to the short wave-lengths and that the region between λ2880 and λ2960 has been neglected. In his reply, the **Author** stated that the effect of the radiations from λ2850 upwards is common to both cover-glass and phenol experiments, yet the resulting erythema in the latter case is far greater than in the former, which points to the fact that the region between λλ2500 and 2850 is far more effective than that between λλ2950 and 2750. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

574. *Temperature Control in Glass-melting Furnaces.* **C. N. Fenner.** (Phys. Rev. 11. pp. 141–143, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—The Rochester works of the Bausch and Lomb Optical Co. have for some time been equipped with thermo-elements of Pt–Pt-Rh introduced through the furnace walls and leading to a direct reader conveniently placed for observation by the furnace men, but the regulation of temperatures based upon these has been unsatisfactory. Optical pyrometers constructed on the principle used in the Holborn-Kurlbaum and Morse instruments have now been installed, and careful tests carried out by the author and F. E. Wright have shown the instruments to be quite reliable. Certain difficulties in glass-making have practically disappeared since the introduction of the optical pyrometers, by means of which a close control can be exercised and the temperature kept within a narrow temperature range, which is very necessary in certain cases. A. W.

575. *Emulsions.* **W. P. Davey.** (Phys. Rev. 11. pp. 138–139, Feb., 1918. Abstract of paper read before the Am. Phys. Soc.)—The use of gasoline and similar organic solvents for japan is attended by a considerable fire and accident risk, and hence it seemed desirable to devise some means of applying japan which did not involve the use of inflammable solvents. It has been found possible to emulsify the oils used in making japan bases (linseed oil, wood oil, etc., their compounds and polymers) by merely heating them with an aqueous solution of an alkali in an enclosed space. The alkali used in the present experiments was ammonia. Since the emulsification can only take place at the interface between the oil and the water, the process may be hastened by means of a stirrer with baffles, rotating at 30 to 60 r.p.m. All the alkali and a little water may be added to the oil-phase (in this work the japan base) at first, later adding water gradually, or the whole of the water may be added to the alkali and oil-phase at once. At present, the first method is to be preferred, since it gives an emulsion of greater fineness. All the emulsions thus made have formed a scum on the surface if left exposed to the air at room temperature. This has been shown to be due to CO_2, for if air from the room is carefully freed from CO_2, it may be bubbled through the emulsion for a whole day without the formation of scum. If, however, the temperature of the emulsion is kept below 16° C., no scum will form in the presence of CO_2-laden air. The droplets of the discontinuous phase of the emulsion are negatively charged. This offers a method for separating the discontinuous from the continuous phase by the introduction of electrodes into the emulsions. The deposition of the discontinuous phase upon the anode is an example of real electroplating, for the amount deposited is strictly proportional to the product of the current and time, and is independent of the voltage employed except in so far as the voltage affects the strength of the current. No attempt has been made to measure accurately the velocity of transport of the discontinuous phase under an electric field, but rough measurements indicate that it is not less than 10^{-4} cm. per sec. per volt/cm. This is of the same order as the velocities of other colloids and ions at the same temperature. A. W.

576. *Metallographic Investigation of the System: Zinc and Selenium.* **M. Chikashige** and **R. Kurosawa.** (Kyōtō Coll. Sci., Mem. 2.

pp. 245–248, July, 1917.)—When zinc and selenium are melted together, solution does not take place, but the compound ZnSe forms more and more rapidly as the temperature is raised. The compound separates as a solid from the fused components, which latter, on cooling, solidify in two separate layers. ZnSe possesses a beautiful yellow colour and has a density of 5·29 at 21°; it remains unchanged, even on heating to 1100°. T. S. P.

577. *Metallographic Investigation of the System: Tellurium and Aluminium.* **M. Chikashige** and **J. Nosé.** (Kyōtō Coll. Sci., Mem. 2. pp. 227–232. July, 1917.)—By means of cooling curves and photomicrographs it is shown that tellurium and aluminium form the two compounds Te_3Al_2 and $TeAl_5$, Te_3Al_2 has m.p. 895°, and forms a series of mixed crystals with Te, saturation being reached with 4·4 % of free Te. The mixed crystals exist in two allotropic forms, α and β, the transition temperature being 541°. The α-mixed crystals and Te give a eutectic at 414°, containing 2·8 % of Al. Te_3Al_2 and Al form a eutectic at 621°, containing 97 % of Al. At 551° the conglomerate which consists of the compound Te_3Al_2 and either Al or the eutectic undergoes change with the formation of the compound $TeAl_5$. Both the compounds are decomposed by water, tellurium hydride being evolved, which then decomposes into Te and hydrogen. T. S. P.

578. *Metallographic Investigation of the System: Aluminium and Selenium.* **M. Chikashige** and **T. Aoki.** (Kyōtō Coll. Sci., Mem. 2. pp. 249–254, July, 1917.)—By means of cooling curves and photomicrographs it is shown that selenium and aluminium form the compound Al_2Se_4, which melts at 950° and is readily decomposed by moist air or water. The two eutectics consist practically of pure Al and pure Se. T. S. P.

579. *Metallographic Investigation of the System: Cadmium and Selenium.* **M. Chikashige** and **R. Hikosaka.** (Kyōtō Coll. Sci., Mem. 2. pp. 239–244, July, 1917.)—It is shown that with increase in temperature cadmium and selenium unite with increasing velocity to form the compound CdSe. The reaction is, however, never complete, since the components volatilise away at comparatively low temperatures, whereas the compound does not melt even at 1350°. When the components are melted together the compound separates out straight away from the reaction mixture, and if the system is then cooled the two components solidify in two separate layers. The compound CdSe is ashen-grey in colour, brittle, and has d_{16°, 5·81. T. S. P.

580. *Metallographic Investigation of the System: Selenium and Antimony.* **M. Chikashige** and **M. Fujita.** (Kyōtō Coll. Sci., Mem. 2. pp. 233–237, July, 1917.)—By means of cooling curves and photomicrographs it is shown that selenium and antimony form the compound Sb_2Se_3, which, with antimony, gives a eutectic at 497° containing 46·5 % of Sb. The eutectic formed between the compound and Se is practically at the melting-point of Se itself. T. S. P.

581. *Experiments on the Fatigue of Brasses.* **B. P. Haigh.** (Inst. of Metals, J. 18. pp. 55–77; Disc. and Corres., 78–86, 1917. Engineering, 104. pp. 315–319; Disc., p. 310, Sept. 21, 1917.)—By "fatigue" is meant the failure of metals in a brittle manner after the continued application of alternating stresses. Experimental evidence is given to show that the phenomena of fatigue for brasses are generally similar to those for mild steel. The effects of corrosion and fatigue are mutually associated, and it is found that fatigue is accelerated and occurs under lower stresses when the conditions tend to promote corrosion.

The results of experiments are given to show the effects of annealing, on tests carried out under stresses alternating between equal intensities of direct pull and push, and to show the relation between the limiting range of stress required to produce fatigue and the ratio between the maximum and minimum stresses.

A study is made of the phenomena of elongation under stresses greater than the fatigue limit, but less than the ultimate tensile strength of the material. C. O. B.

582. *Transformation of Martensite in Hypoeutectoid Steel.* **M. Matweieff.** (Rev. Soc. Russe de Métal. 1. pp. 149–155, 1916. Rev. de Mét. 14E. pp. 44–48, Jan.–Feb., 1918.)—Experiments were made with a steel of 0·26 to 0·3 C, 0·6 to 0·9 Mn, 0·2 to 0·4 Si, less than 0·035 S and less than 0·05 % P. Rods, 14 mm. in diam. 80 mm. high, were placed with the lower end in a kryptol furnace, this end being heated to incipient fusion, while the upper end was not heated; the whole cylinder was then quenched in cold water, and the successive layers were examined. The end that had been heated showed large crystals of martensite (in regular triangles or squares), the upper cold end pearlite and ferrite, and transitions were observed in the intermediate layers. Reheating the specimens up to 300° made no difference in the texture; then striæ of sorbite made their appearance in the martensite, but an essential modification was observed only after reheating to 750°. Quenching much above $A_{2\text{-}3}$ gave a martensitic steel, mechanically weak, of small elongation; the fine martensitic texture produced at temperatures slightly above $A_{2\text{-}3}$ is mechanically strongest; when, at slightly lower temperature, martensite and ferrite appear, the breaking strength is high, but the elongation is feeble. Specimens were also heated in a muffle furnace. Quenching sets in spontaneously about 800°; when such steel is not reheated, the breaking strength diminishes with higher quenching temperature, and there is no elongation. On reheating other effects are observed; the breaking strength increases as the quenching temperature is raised, and the elongation reaches 12 %. H. B.

583. *Allotropic Transformation and Microstructure of Nickel-Chrome Steels.* **A. N. Masloff.** (Rev. Soc. Russe de Métal. 1. pp. 495–515, 1915. Rev. de Mét. 14E. pp. 37–44, Jan.–Feb., 1918.)—Referring particularly to Guillet, Grenet, Revillon the author points out that the apparently contradictory observations of these workers may be due merely to different modes of experimenting. The specimens of 13 steels—carbon 0·3 to 0·69 %, manganese about 0·3, silicon about 0·3, phosphorus about 0·03—ranged as to chromium from 0 to 2 %, and as to nickel from 1 to 5·5 %. The bars of 12 by 13 by 20 mm., about 50 gm. in weight, were forged, quenched in cold water and heated in an Heraeus furnace. It resulted that the max. heating up to 400 deg. above the transformation-point affected the transformation temperature Ar_1 on cooling very little, if at all, and that the rate of this heating was of no importance either, the Ni-Cr steels behaving like ordinary carbon steels, provided the rate of cooling remained unchanged. The rate of cooling in the interval between 550° and 750° was the important factor. So long as the rate of cooling did not exceed 3·2 deg. per minute, the transformation was the same as that for the respective Ni steel free from Cr, and the microstructure showed troosite with pearlite zones. When the rate of cooling was raised, the transformation temperature was lowered to 400°, 300° and lower, and became indistinct, the more so, the higher the Ni and Cr contents: martensite made its appearance, and when the rate of cooling went up to 18 deg. and 30 deg. per minute, there might be no transformation, and the texture became altogether martensitic. Thus the cooling curve of Ni-Cr steels has in itself no interest apart from the rate of cooling. Nickel in general tends to lower the Ar_1 point, while chromium has a different relative effect. The Cr does not lower the point, but it delays the transformation and makes it dependent upon the rate of cooling; when the cooling is slow, the transformation occurs at the temperature corresponding to the Ni percentage; the influence of Cr becomes distinct only at high rates of cooling. The Cr makes the steel harder and more homogeneous. H. B.

584. *Grain-size Measurements.* **Z. Jeffries.** (Met. and Chem. Eng. 18. p. 185, Feb. 15, 1918.)—Certain refinements in the manipulation of the method for the measurement of grain-size described in Abs. 1195 (1917) and 208 1918) are recommended. Extended use has indicated that the factor for converting the boundary grains into the equivalent number of whole grains is 0·5, instead of 0·6 as originally stated. F. C. A. H. L.

585. *A Criterion for Allotropic Changes of Iron at High Temperatures.* **K. Honda.** (Tôhoku Univ., Sci. Reports, 6. pp. 213–217, Nov., 1917. Twelfth Report of the Alloys Research Inst.)—During recent years there has been considerable discussion as to whether the transformation occurring at A2 is or is not an allotropic change. It is now fairly well established that the A2 change is a gradual one taking place over a comparatively wide range of temperature, while the A3 and A4 transformations occur at fairly definite temperatures. Now almost the whole of the physical properties of a homogeneous substance which does not undergo any transformation will vary with the temperature. Considerations of specific heat will show that a certain amount of heat must be absorbed during heating and given off during cooling, which amount is very difficult to determine by thermal analysis. While therefore there is no room for doubt in the case of a discontinuous change, in the case of a gradual change it is very difficult to decide whether the change is or is not allotropic. The essential difference is that in a non-allotropic change the properties are definite functions of the temperatures, whereas in an allotropic transformation this is not necessarily the case. An allotropic change is defined as the transformation of a substance from one phase to another at a definite temperature if a sufficient time is allowed for the transformation. Regarded in this light, it appears that while A3 and A4 are definite allotropic changes, A2 is simply an internal change taking place over a wide range of temperature, every stage of which change is a definite function of the temperature. In the case of steels A0 is to be regarded as of a similar nature to the A2 transformation, while A1 is a definite phase-change. F. C. A. H. L.

586. *Spontaneous Generation of Heat in recently Hardened Steel.* **C. F. Brush.** (Am. Phil. Soc., Proc. 56. pp. 353–363, 1917.)—In previous papers [Abs. 1783 (1915) and 564 (1917)] the author has shown that carbon steel, high-speed steel, and nickel-chrome steels after quenching in water from high temperatures, spontaneously generate heat at a steadily diminishing rate for several weeks. Experiments have been made on a sample of nickel-chrome steel containing 0·54 % C, 3·32 % Cr, and 2·23 % Ni. On heating, it showed almost complete loss of magnetic susceptibility at 777° C., while on cooling complete recovery occurred at 660° C. Quenching from above the decalescence point results in spontaneous generation of heat, the amount of which is increased on increasing the quenching temperature. A specimen heated to above the decalescence point and quenched gave a generation of heat which, though marked, was not as great as that generated by the truly hardened steel. Annealed specimens heated to temperatures up to 667° C. and quenched showed subsequent absorptions of heat. Experiments with a plain carbon steel of 1·64 % carbon content showed that there was no spontaneous generation of heat unless actual hardening had occurred, and that no absorptions of heat occurred subsequent to quenchings from temperatures below the recalescence point. A white iron with 3·48 % combined carbon also generated heat spontaneously after quenching from above the decalescence point, but the heat generated was less in amount and less persistent than that generated from a carbon steel. Pure Swedish iron showed neither generation nor absorption of heat after quenching.

F. C. A. H. L.

587. *Anomalous Elasticity of Carbon Steels and the Reversible Transformation of Cementite.* **P. Chevenard.** (Comptes Rendus, 166. pp. 73–76, Jan. 14, 1918.)—The anomalous properties of nickel-steels [see Abs. 1845 (1914), 365 (1915), 1189 (1917)] suggested the existence of an anomalous elasticity of carbon steel connected with the magnetic transformation and the dilatation of cementite. The experiments were made in the Imphy Steel Works with pure steels of 1·5 % C, maximum. The specimen formed the suspension wire, 0·23 mm. in diam., of a torsion balance; it was placed within an electric furnace, and the oscillation period and successive elongations corresponding to different temperatures up to 400° were observed for the determination of the decrement and of the modulus of torsion μ. It is essential that all the specimens have previously undergone the same thermal treatment; non-observance of this rule probably explains the author's disagreement from F. Robin and from C. E. Guye. For temperatures below 300° the decrement was always very small, and the twist-torque curve a straight line; the modulus varied in the inverse ratio of the squares of the periods at 0° and 15°. Above 300° the decrement increased considerably and the twist-torque curves showed a notable hysteresis. In the relative modulus curves an inflection is noticed near the Curie point at 210°, particularly with high C percentage; the curves refer to three steels of 0·49, 1·03, 1·5 % C. Up to this point the curves were nearly rectilinear, beyond they were more curved, but parallel. The elasticity anomaly due to the transformation of cementite seems to be proportional to the carbon percentage. H. B.

588. *Quenched and Cold-worked Carbon Steel.* **F. Cloup.** (Comptes Rendus, 166. pp. 415–416, March 11, 1918.)—The heating curves of steels, quenched or submitted to cold work, always show liberation of heat near 400°. The changes of state which the steels undergo at this temperature are slow in both cases. Thus two specimens of a steel of 0·12 % C., the one quenched at 1000° in cold water, the other cold-worked, both heated to 640° for 25 minutes, showed this point at 400° on being reheated; when the steels were kept at 600° for 12 hours, however, the changes were complete, and the heating curve no longer marked any irregularity. This change is irreversible, and the cooling curves do not show any peculiar points. The transformation must be accompanied by a brisk change of volume; the steel is not malleable at 400° and becomes the seat of internal stresses; when these stresses are increased by external means (hammering, e.g.), fissures may develop, as is well known. H. B.

589. *Use of Chromic Acid and Hydrogen Peroxide as an Etching Agent.* **S. W. Miller.** (Inst. of Metals, J. 18. pp. 253–255, 1917. Engineering, 104. p. 298, Sept. 21, 1917.)—For etching brasses and bronzes before microscopical examination, a dilute solution of chromic acid, to which a few drops of hydrogen peroxide has been added, is advised. The addition of the hydrogen peroxide causes a strong effervescence and turns the solution of chromic acid a very dark green. If the chromic acid solution is too strong, large gas-bubbles are evolved which prevent uniform etching. When the right strength of solution is used, the immersion of the specimen causes a spitting of the liquid, particles of which are projected from the bath on to the sides of the containing vessel.

In the case of copper-tin alloys the α is not stained, and the δ remains a light blue. In the copper-zinc alloys both the α and β are said not to be changed in colour, while in rolled brass the grain boundaries and twin crystals are brought out with great clearness. This reagent also gives good results with silver alloys. C. O. B.

590. *Contact Catalysis.* II. **W. D. Bancroft.** (J. Phys. Chem. 21. pp. 644–675, Nov., 1917.)—From his further examination of the work done in reference to contact catalysis, the author draws the conclusions: (1) At low temperatures the nature of the catalytic agent may determine which of two combustible gases will burn the more rapidly. (2) As might be expected, hydrogen burns more readily than methane or ethylene in presence of Pt. (3) From Landolt's experiments the same seems to be true in the flame provided a Pt tube is inserted; but these experiments should be repeated. (4) In presence of copper oxide at 250°, all the hydrogen in a mixture of hydrogen and methane can be burned without any of the methane being decomposed. (5) In the presence of chamotte at 500°, hydrogen burns much more readily than methane. So little is known about the absorption by chamotte that this result could not have been predicted. (6) In borosilicate glass bulbs at 300°–400°, methane, ethane, ethylene, and acetylene are oxidised much more rapidly than hydrogen or carbon monoxide. (7) When mixtures of methane, oxygen, and hydrogen or carbon monoxide are exploded by an electric spark, the methane burns much more rapidly than either the hydrogen or the CO. (8) Depending on conditions, either hydrogen or CO will burn the more readily. (9) Since charcoal causes ethylene to be oxidised to CO_2 and water, and since charcoal has very little effect on a mixture of hydrogen and oxygen, it is probable that charcoal would cause preferential burning of ethylene in a mixture of ethylene and hydrogen. (10) By suitable selection of the catalytic agent, it should be possible to get all intermediate stages from complete burning of methane to complete burning of hydrogen. (11) Since relatively more methane was burned in the explosion experiments the larger the bulb, it seems probable that methane burns more readily than hydrogen at high temperatures and in the absence of solid catalytic agents. (12) At very high temperatures the specific effect of the solid catalytic agent must become negligible because the reaction will take place so rapidly in the gas phase that the equilibrium reached will be that of the gas phase and not that of the catalytic agent. A. F.

591. *Contact Catalysis.* III. **W. D. Bancroft.** (J. Phys. Chem. **21.** pp. 784–775, Dec., 1917.)—In continuation of previous papers [see preceding Abs.] the author further discusses contact catalysis. Among the conclusions which he draws are that since contact catalysis involves adsorption, a decrease in the adsorption, for example, by a film of solid, liquid, or gas on the solid catalyst, will mean a decrease in the reaction velocity. Since the presence of the products of reaction will decrease the rate at which the reacting substance will diffuse to the catalytic agent, and since the reaction products may decrease the adsorption of the reacting substances, the reaction products may decrease the reaction velocity if they are not removed. When a colloidal metal is kept in suspension by the addition of gelatine or other substance, the stabiliser may diminish the adsorption, and consequently may tend to decrease the reaction velocity. The action of fluoride ions, etc., in increasing the anode overvoltage is undoubtedly due to the fact that they decrease the catalytic action of the anode on the reaction $2O \longrightarrow O_2$. An increase in the overvoltage at the kathode could undoubtedly be obtained by taking a suitably acidified solution of zinc sulphate or cadmium sulphate. It is possible that the addition of copper salts in the electrolytic determination of nitrates is analogous to the addition of chlorides or fluorides in the electrolytic formation of persulphates.

A. F.

592. *Electrolytic Deposition of Alloys.* VIII. *Iron and Iron-Nickel at Ordinary Temperature and High Hydrogen Pressure.* **R. Kremann** and **H. Bregmesser.** (Monatsh. d. Chemie, 38. pp. 359–384, Dec., 1917. Engineering, 105. p. 434, April 19, 1918. Abstract.)—The equilibrium potential of hydrogen with respect to pure water being —0·41 volt, and that of iron in normal solution of $FeSO_4$ —0·46 volt, the electrolyte becomes depleted of H-ions in the immediate neighbourhood of the kathode, and hydrogen and hydroxyl are deposited with the iron. To prevent this the electrolysis should be conducted in hot concentrated solutions, preferably of iron chloride, which is more soluble than the sulphate; for working at low current densities the electrolyte may be acidified, but the current yield is lowered in such case. As regards the hydrogen, a distinction has to be made between the gas pressure of the hydrogen in the electrolyte and the hydrogen dissolved in the iron, and to keep the latter percentage low, the gas pressure of the hydrogen should be high (not low). Placing the electrolytic cell within a small steel boiler, the authors find that their iron contained 0·088 per cent. of H when the hydrogen gas pressure was 1 atmo., and 0·015 when this pressure was 20 atmos. In the analyses about 2 gm. of iron was oxidised in oxygen, when 1 or 2 mgm. of water was obtained. The presence of hydrogen is generally supposed to render the iron hard and brittle (mechanical tests were also made), especially on the side in contact with the kathode; the authors suggest that this brittleness depends not directly upon the presence of hydrogen, but rather upon a certain structural arrangement arising under certain conditions, to avoid which the bath should be hot (75° C.) and neutral. The magnetic properties of the iron are hardly affected by the conditions of the electrolysis. Deposited under hydrogen pressure from normal $FeSO_4$ the iron at once shows the equilibrium potential, which it only reaches after a considerable time under other conditions. Attempts to improve iron-nickel alloys by working under high hydrogen pressures failed. Mixed ferrous and nickelous sulphates yield alloys poorer in nickel than the bath, and the alloys are brittle; the two metals do not appear to alloy when electrolytically deposited together.

H. B.